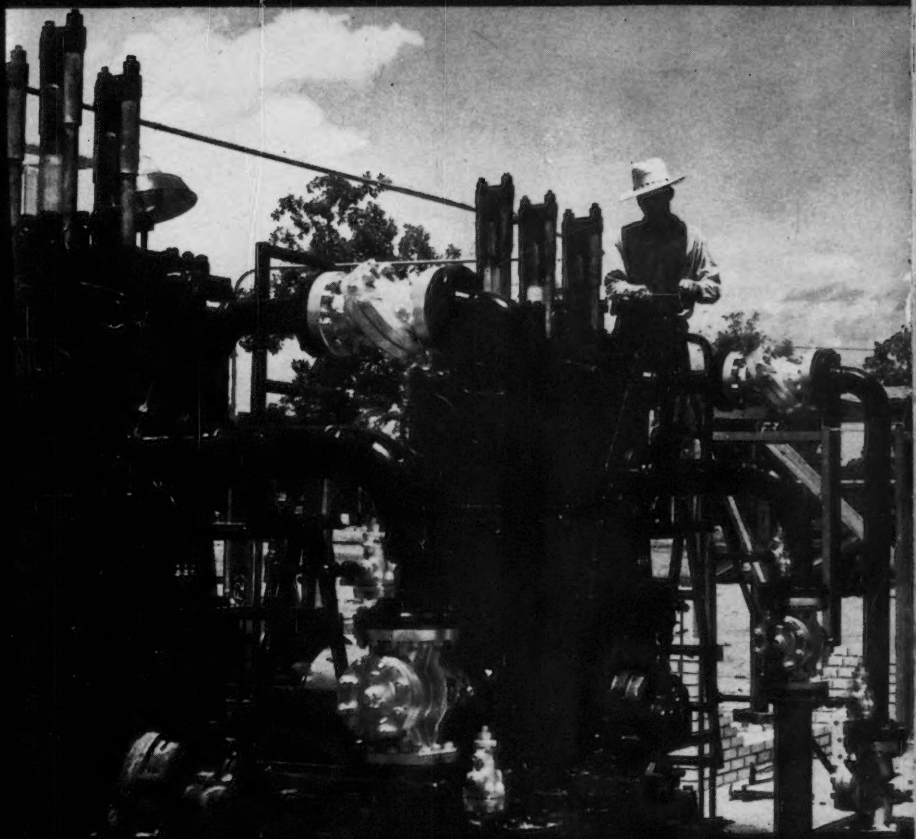
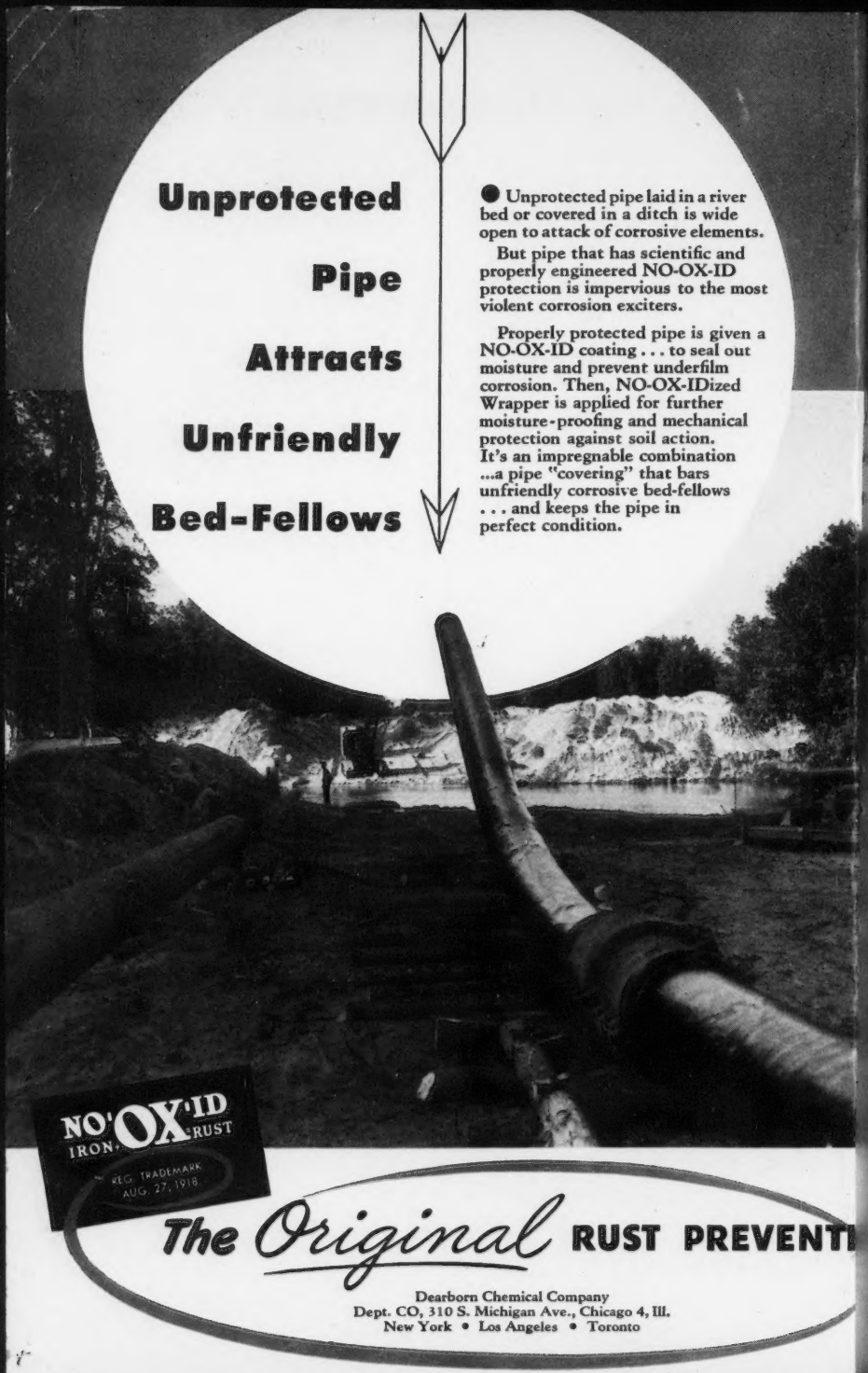
Corrosion

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devoted entirely to

CORROSION

Research and Control

PUBLISHED MONTHLY AS ITS OFFICIAL JOURNAL, BY THE NATIONAL ASSOCIATION OF CORROSION ENGINEERS, INC., AT HOUSTON, TEXAS, U. S. A., TO PROVIDE A PERMANENT RECORD OF PROGRESS IN THE CONTROL OF CORROSION AS DESCRIBED IN PAPERS PREPARED FOR THE ASSOCIATION AND FROM OTHER SOURCES.

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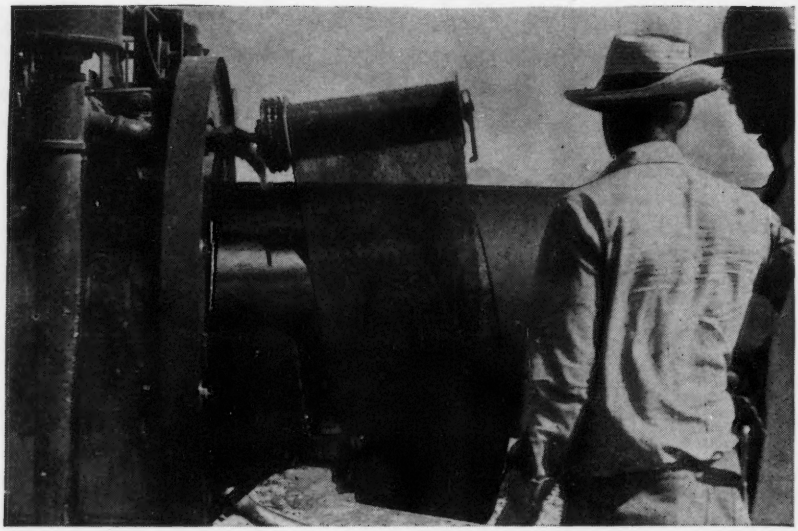
THIS MONTH'S COVER

• ***Checking triplex pumps at the Sheridan Station on the Shell Pipe Line Corporation's products pipeline. Pumps suffer attack attributable to corrosion corresponding to the product being handled. Similar pumps in sour crude service frequently deteriorate rapidly. Adjacent to the pumps pictured is located injection equipment for the purpose of adding inhibitors, which tend to protect the pumps as well as the line into which the chemical is injected. Photograph, courtesy Shell Pipe Line Corporation.***



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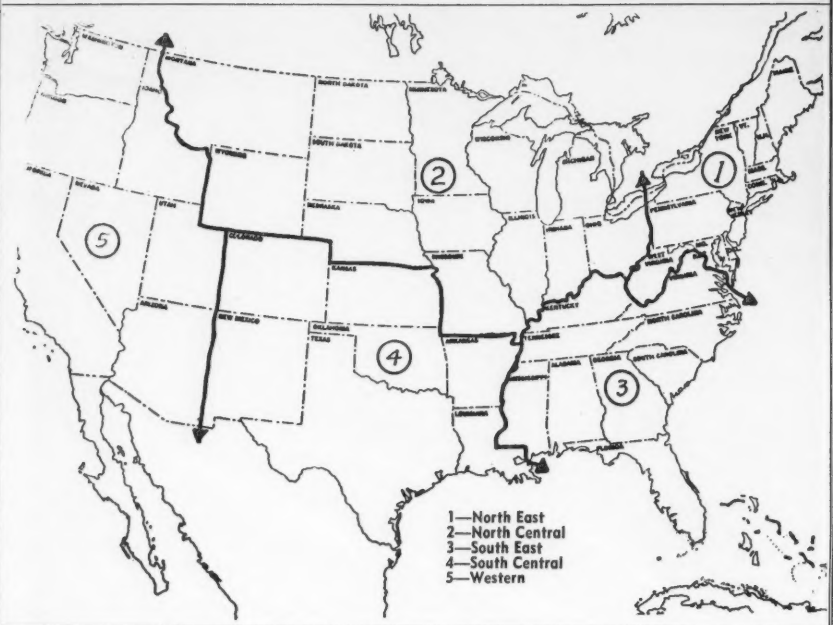

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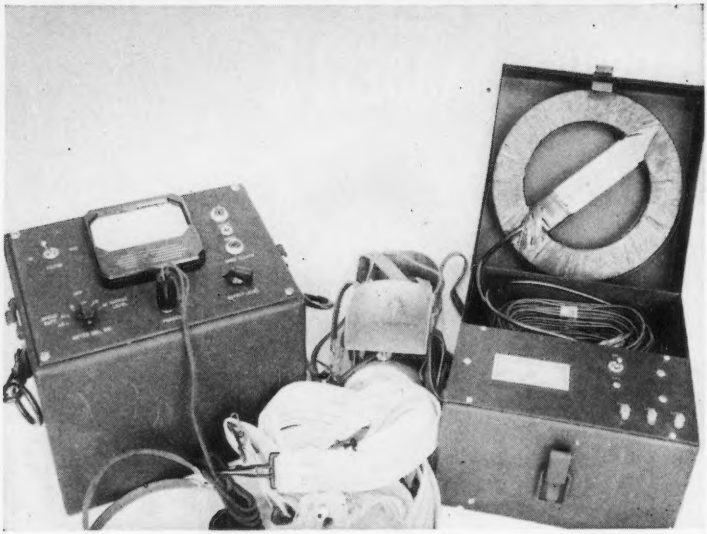

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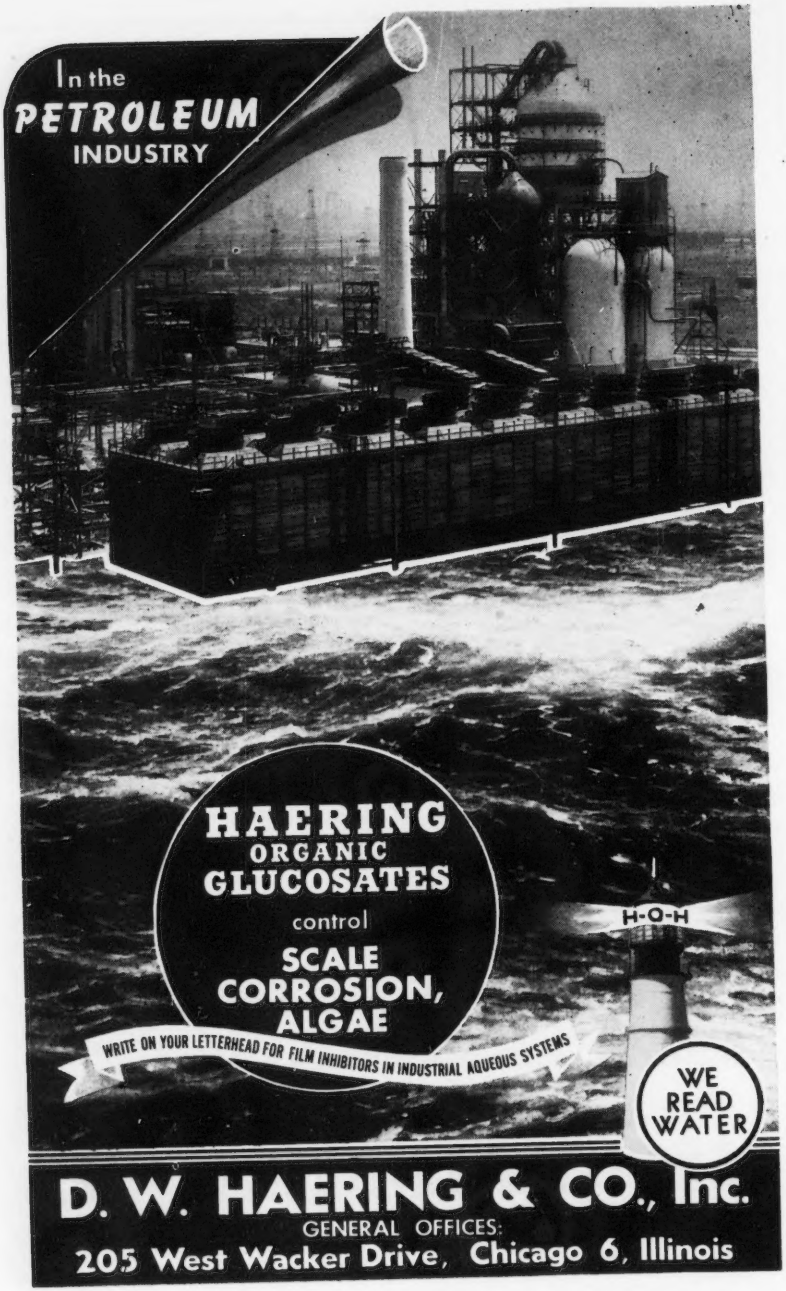
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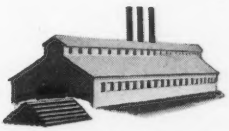

Modern equipment for the proper application of primers and enamels over mechanically cleaned pipe is available at numerous application contractors' plants, which apply Barrett protective coating systems while the pipe is in transit to your destinations.

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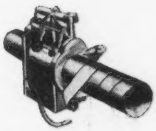

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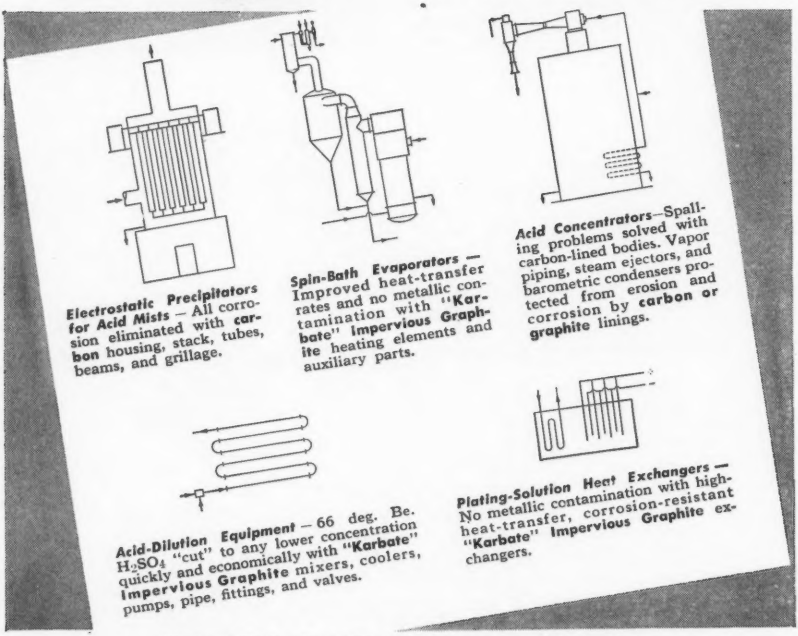

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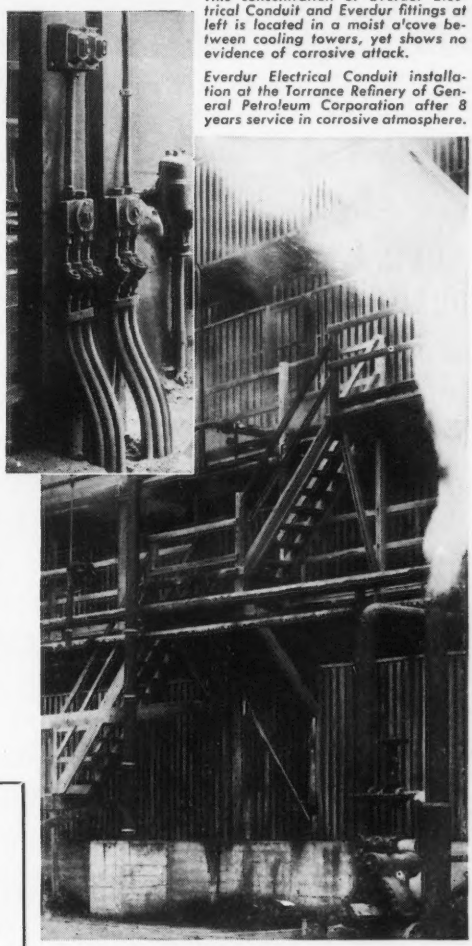

This concentration of Everdur Electrical Conduit and Everdur fittings at left is located in a moist alcove between cooling towers, yet shows no evidence of corrosive attack.

Everdur Electrical Conduit installation at the Torrance Refinery of General Petroleum Corporation after 8 years service in corrosive atmosphere.

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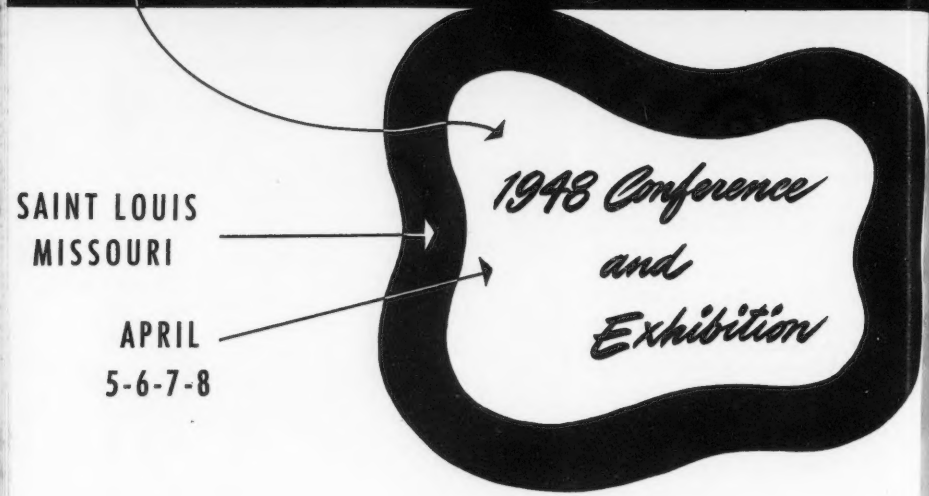

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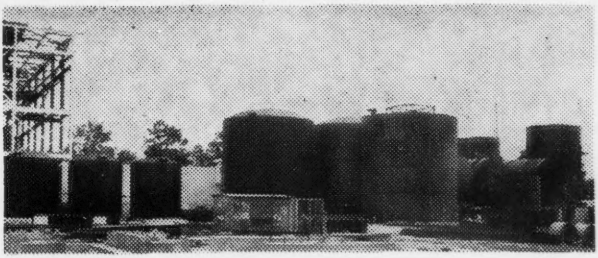

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(c) to promote methods of control of corrosion.

(d) to promote standardization of terminology, methods, equipment and design in the development of methods of corrosion control.

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It is an incorporated association without capital stock, chartered under the laws of Texas. Its affairs are governed by a Board of Directors, elected by the general membership. Officers are nominated by (1) the Board of Directors, or (2) a quorum of at least 25 members, and elected by the membership.

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Experiences in Conditioning Corrosive Army Water Supplies in New England*

By George P. Loschiavo*

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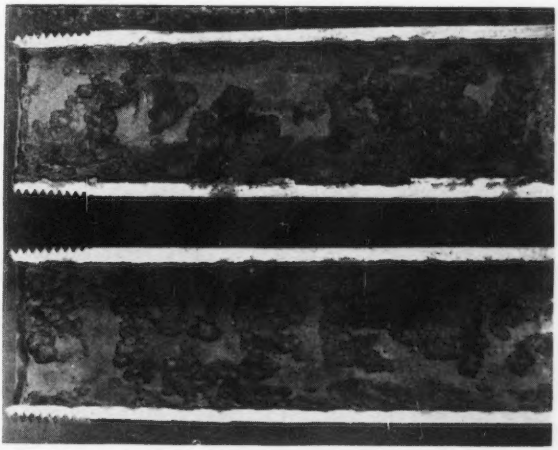

Figure 1—Effect of silicate treatment on tuberculated pipe (90 days). Site, Camp Miles Standish.

★ A paper presented at the Annual Meeting of NACE in Chicago, Ill., Apr. 7-10, 1947.

* 419 Elm Road, Ambridge, Pa.

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is a non-profit, scientific and research association of individuals and companies concerned with corrosion or interested in it, whose objects are:

(a) to promote scientific research in determining the causes of corrosion and methods of its control with respect to theory and practice.

(b) to provide a means of exchange of knowledge and ideas among those individuals actively engaged in the control of corrosion.

(c) to promote methods of control of corrosion.

(d) to promote standardization of terminology, methods, equipment and design in the development of methods of corrosion control.

(e) to foster cooperation between individaul owners of metallic structures in the solution of their joint corrosion problems.

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Well Water Supplies

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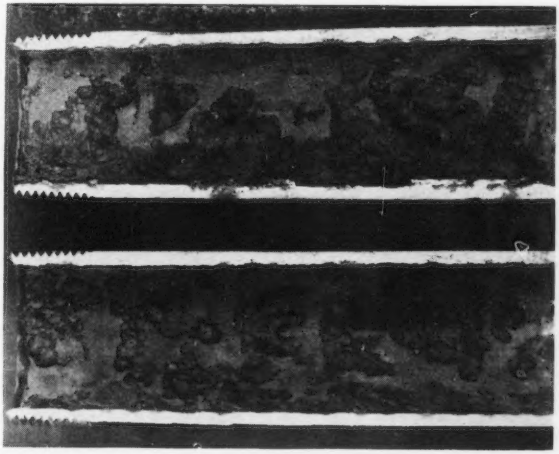

Figure 1—Effect of silicate treatment on tuberculated pipe (90 days). Site, Camp Miles Standish.

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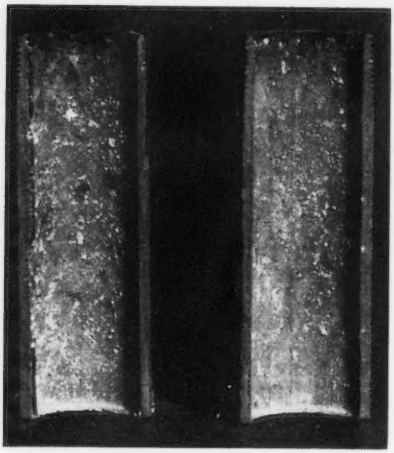


Figure 2—Effect of silicate treatment on new galvanized steel pipe (90 days). Site, Camp Miles Standish.

with success. In order to maintain a pH control of the 8.2 to 8.4 at a central point, an initial pH of 9.0 was achieved at the wells, which are located approximately one-half mile from the nearest service tap. The natural silica content of the water at Camp Myles Standish is 13 ppm., which accounted for the calcium silicate coating found on test-nipples. As the natural silica content of the well water at Camp Edwards was 3 ppm., sodium silicate (Type 3)* was added to yield a total silica of 10 ppm.

During the first two months after treatment commenced at Camp Edwards, the iron concentration in the distribution system went as high as 30 ppm., but later fell back to less than 0.1 ppm. It is interesting to note that although the treated water was effective in inhibiting corrosion, Langelier's Index for this water still remained negative. Experience from visual inspection and scale analysis of test-nipples indicated that there was some deposition of calcium even though saturation was not achieved.

At Fort Terry, approximately 15 to 20 ppm., of lime slurry was fed into the suction side of the well pump. Sodium silicate (Type 2) was injected (17 ppm.) into the discharge side of the well pump. An inspection of the hot-water system prior to treatment showed heavy tuberculation. Removal of tuberculation was achieved with the hexametaphosphate treatment. Inspection of test-nipples showed good results with the silicate treatment. To eliminate heavy calcium silicate scaling, the silicate treatment was discontinued periodically to allow descaling of pipe.

Surface Supplies

A unique opportunity presented itself at the Boston Army area to compare various chemicals at five separate posts all using Metropolitan District Commission water. Nine installations were established**; six involving chemical treatment, two with galvanized steel loops subjected to untreated water and one with a phenolic resin-baked loop also subjected to untreated water. All installations were outfitted with galvanized steel test loops comprised of six 1½ inch by 24 inch test nipples (pre-weighed); a test nipple was removed from each installation every six months and sent to the American Iron & Steel Institute, New York, for physical examina-

* The various silicate types used are listed in the appendix.

** This project was conducted through supervision of Office Chief of Engineers, Washington, D. C., and in conjunction with the American Iron & Steel Institute, New York, N. Y.

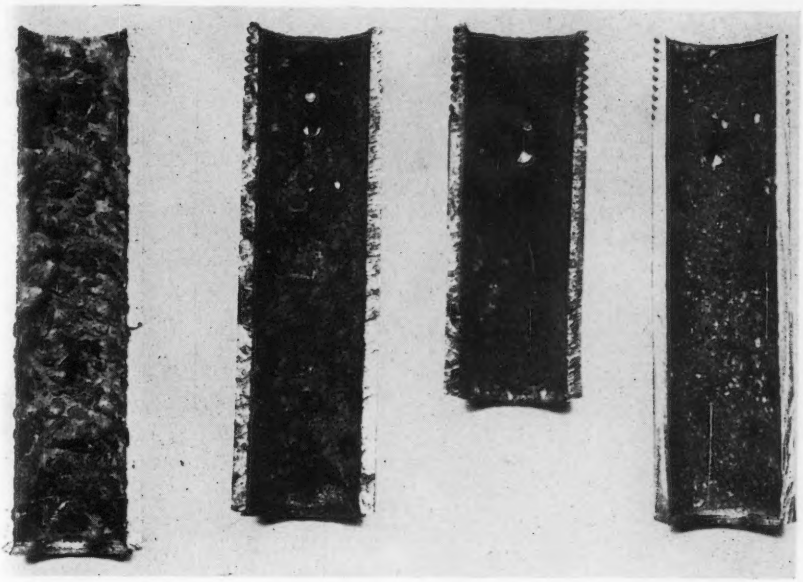


Figure 3—Lime-silicate treatment. Site, Otis Field Fire Station. Left to right: 1—New galvanized steel before treatment; 2—New black steel after treatment; 3—Used galvanized steel after treatment; 4—New galvanized steel after treatment. Specimens 2, 3, and 4 exposed 14 weeks.

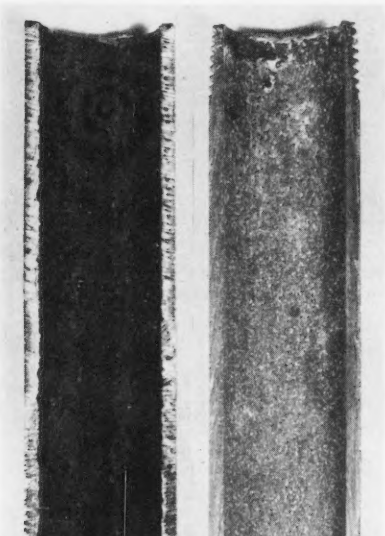
tion. The installations and treatments are listed as follows:

1. Ft. Banks: Sodium silicate (Type 3), 35 ppm.
2. Ft. Banks: Sodium silicate (Type 3), 35 ppm., calcium chloride, 20 ppm.
3. Ft. Dawes: Sodium silicate (Type 3), 20 ppm., hexametaphosphate, 2.5 ppm., caustic soda, 3 ppm.
4. Ft. Ruckman: Hexametaphosphate, 10 ppm.
5. Ft. Ruckman: Untreated water supply, galvanized steel test-loop.
6. Ft. East Point: Nalco 918, 10 ppm.
7. Ft. East Point: Tetra-phospho-glucosate, 12 ppm.
8. Ft. Heath: Untreated water supply, phenolic resin-baked test-loop.
9. Ft. Heath: Untreated water supply, galvanized steel test-loop.

Due to unavoidable delays, all of the installations were not initiated at the same time. Corrosion installations No. 1 and 3 were established in September, 1944; No. 4, 5, and 9, in February, 1945; No. 6 and 8, in July, 1945; and No. 2 and 7, in September, 1945. The project is still in progress and should be completed in September, 1948, at which time all test-nipples will have been removed and inspected. Experience to date can be based on installations 1, 3, 4, 5 and 9, which include the silicate, silicate-hexametaphosphate-caustic soda, and hexametaphos-

phate (unadjusted) treatments. Of these the hexametaphosphate treatment (unadjusted) gave the best results.

A galvanized steel test-nipple was protected by a dosage of 10 ppm. for 270 days without any signs of corrosion. It was also noted that hexametaphosphate was far more effective in soft waters without pH adjustment. Test-nipples subjected to the silicate treatment at Ft. Banks showed approximately 60 percent metallic coverage with tuberculation present. The silica residuals achieved were evidently insufficient to overcome the initial corrosion attack. At Ft. Dawes, an inspection of a test-nipple subjected to the silicate-hexametaphosphate-caustic treatment for 270 days disclosed a continuous tan-grey coating and 12 to 15 tubercules one-quarter inch in diameter. Other posts that used the sodium silicate treatment for corrosive surface water were Ft. Wright (Type 2), Ft. Foster (Type 2), and Westover Field (Type 1). Results with these waters were more successful than achieved with Boston water.



Old Galvanized Steel used four years. *New Galvanized steel used four months.*

Figure 4—Lime-sodium silicate treatment. Old section of pipe subjected three and one-half years to untreated water. During six-month treatment, porous tubercules removed, and pits hardened.

At Dow Field, various combinations of chemicals were used but in all cases failed to adequately inhibit corrosion until some of the heavy tuberculation present was removed. When a fair percentage of the tuberculation had been removed and flushed out of the system with the hexametaphosphate treatment, sodium silicate (Type 3) was dosed to the water supply. Results disclosed hardening of tuberculation and an increase in water pressures throughout the distribution system.

Water High in Iron

Hexametaphosphate has been used very successfully at several posts to control 2 to 20 ppm. of iron. Treatment involved pH adjustment and dosage with hexametaphosphate part per part of iron present.

Chemicals Used

Silicates

There are three types of sodium silicates used in the New England Army area—the N brand (Philadelphia Quartz Co.) and the Peak

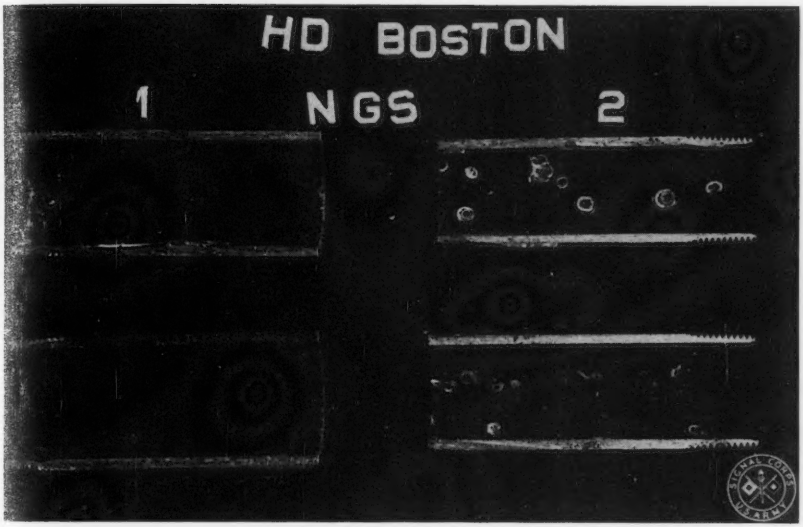


Figure 5—Galvanized steel sections after six-month treatment with sodium silicate. Number 1, cold water section; number 2, hot water section.

and Acme brands (General Chemical Co.). Composition of these and other silicates normally sold on the market are given in the appendix.

Experience with silicates seems to indicate that the initial silica residual of the treated water best suited for laying down a film is from 10 to 20 ppm. as SiO_2. Because the greater percentage of New England waters have low natural silica content, it is difficult to obtain a final silica residual much greater than 10 ppm. This residual is satisfactory in waters having a total hardness of 30 ppm., or more.

Once a protective film was formed throughout the water services, the dosage of sodium silicate was reduced as much as 50 percent. The criteria for the exact dosage was determined by periodic inspection of test-nipples and post-wide water analysis to determine residual silica decreases.

One phase of corrosion control treatment that is too often overlooked is the proper handling of the silicate before and while feeding. Although sodium silicate was thawed out after being subjected to low temperatures, it tended to settle out of solution after being diluted in the treatment crock. When silicates were mixed inadequately, due in part to low temperatures around the chemical feeder, erratic pH control and silica proportioning resulted. Where practical, dilutions were made with hot water and a temperature near 70° F. was kept around the chemical feeders.

Hexametaphosphate

The effectiveness of hexametaphosphate as a sequestering agent

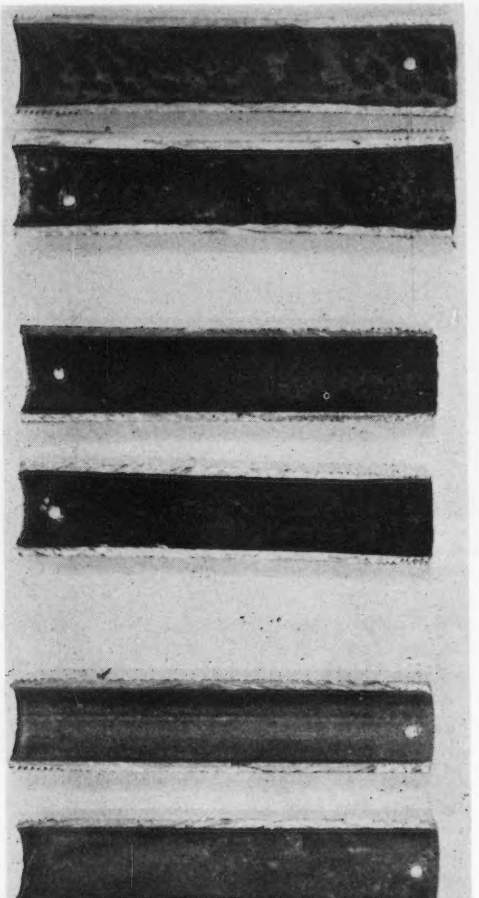


Figure 6—Silicate treatment (90 days). Site, Fort Foster.

Figure 7—Section of four-inch cold water line after two years service in untreated water. Site, Fort Wright.

is well established. Its use to loosen tuberculation and inhibit corrosion has been successful at many posts. Hexametaphosphate dosed to unstabilized water supplies showed good results; while hexametaphosphate with silicates and caustic soda was not successful.

Lime

When used to decarbonate high carbondioxide content waters, lime was very effective, particularly with the presence of high natural silica. Because it is difficult to feed to surface supplies, its use was restricted to well waters only.

Proprietary Polyphosphate

The use of this chemical, which is a polyphosphate, produced results somewhat similar to hexametaphosphate. These tests, however, had been in operation for only 120 days at the time of the last inspection, and definite conclusions cannot be made at this time.

Tetra-Phospho-Glucosate

The phospho-glucosates have enjoyed their broadest applications in boiler feed water and hard (Midwestern) potable water conditioning for scale control. This chemical was tried for the first time in conditioning soft potable water in the

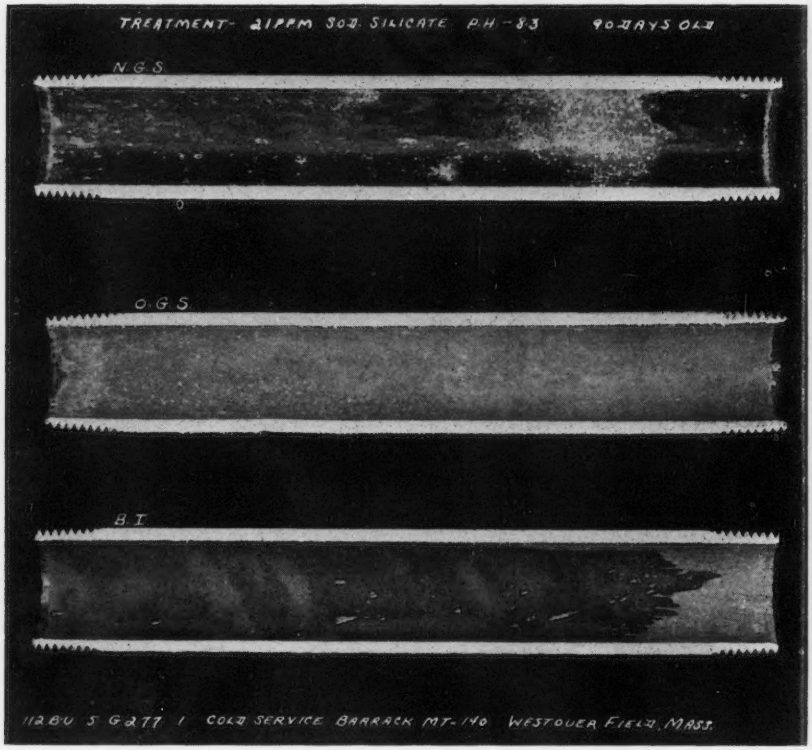


FIGURE 8

Boston area, however, had been in operation for 60 days at the time of the last inspection and definite conclusions cannot be made at this time.

Discussion

The following discussion is based on the writer's extensive experience in conditioning soft waters in the New England Army area.

a. With Reference to Corrosion: Dissolved Gases

(1) Very soft surface water, saturated with dissolved oxygen and low in carbon dioxide will prove corrosive in both cold and hot water services. The nature of the corrosive action is evidenced by irregular tuberculation and pitting; the tubercules being soft and porous. The carbon dioxide content remains almost constant all year while the dissolved oxygen varies (being higher in the Fall and Winter seasons). In cold water services, the rate of corrosion increases with the increase of temperature and dissolved oxygen. In hot water services (the temperature of the water being held

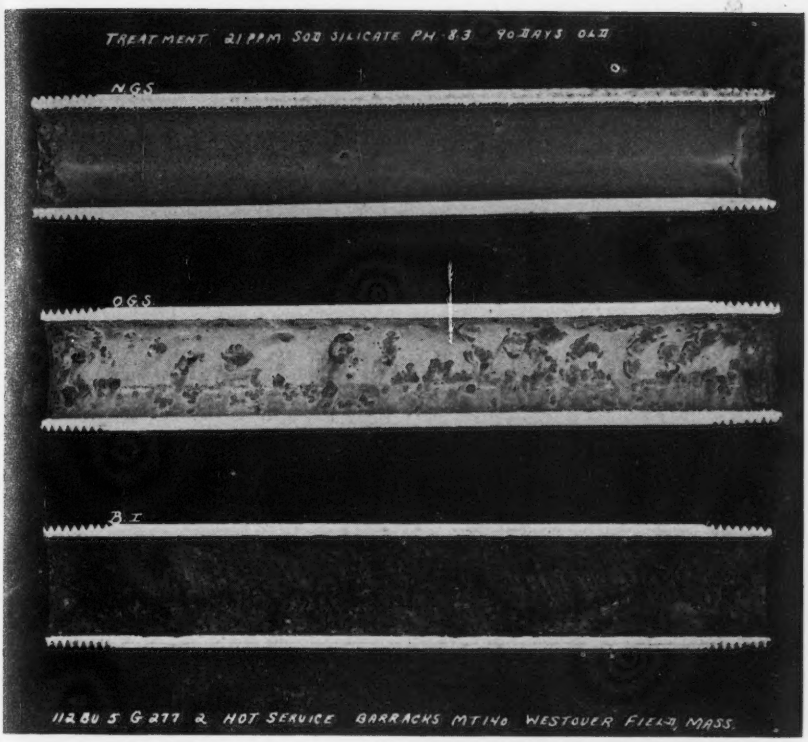


FIGURE 9

constant) and the rate of corrosion will be found to be directly proportional to the dissolved oxygen and water consumption.

In Table I, the posts are listed in the order of the corrosiveness of their water supply as determined by visual inspection.

TABLE I

Corrosiveness of Supplies

Boston Supply	Water Consumption Ratio	Dissolved Oxygen (Average) ppm	Carbon Dioxide (Average) ppm
1. Waltham	16.6	8.0	2
2. Banks	12.0	10.0	3
3. Dawes	5.3	8.0	3
4. Ruckman	2.0	6.5	3
5. Heath	1.0	8.0	3
6. East Point	3.3	2.0	3

(2) Soft well water high in dissolved oxygen and carbon dioxide will prove highly corrosive in both cold and hot water services. In fact, this type of water has proved the most corrosive in the New England Army area. Metallic surfaces are found completely tubereulated, with pitting continuing beneath the tubercules. The tubercules are found to be less porous and somewhat denser than those formed by the water type noted in Paragraph (1). This type of water is found at Camp

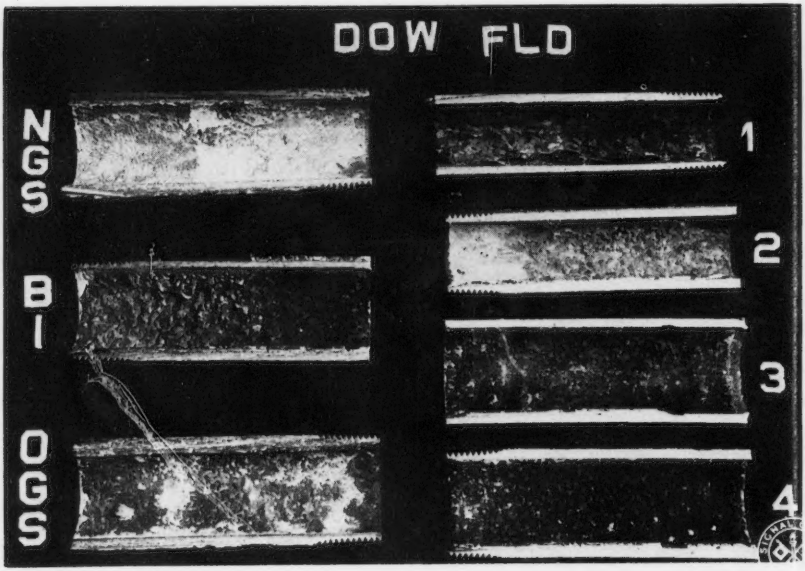


Figure 10—New galvanized steel (NGS); black iron (BI), and old galvanized steel (OGS), one year untreated, 120-day silicate treatment. Hot water nipple 1, hexametaphosphate 10 ppm, 34 days; hot water nipple 2, hexametaphosphate 2 ppm, 83 days; cold water nipple 3, sodium silicate 24 ppm, 220 days; hot water nipple 4, sodium silicate 24 ppm, 220 days.

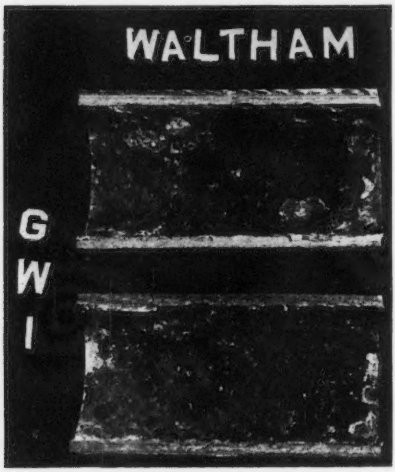


Figure 11—Galvanized wrought iron after two years of service untreated Boston water. Note uniform, durable tubercules.

Edwards and at Fort Terry. In some cases, where the dissolved oxygen is low, piping will show uniform pitting and little tuberculation in cold water services and extreme pitting in hot water services. This condition is evidenced by faucet leaks, "red water," plumbing stains, and complete pitting-through of heater recirculating pipe and steel heater coils. An example of this type water is found at Camp Myles Standish.

(3) Soft well water high in iron content is usually found to have a high carbon dioxide content with little or no oxygen present. In cold water services, corrosion and tuberculation are negligible. Generally, a thin film of ferrous carbonate is

found present on the metallic surfaces. In hot water tanks and heaters, an adherent scale composed mostly of ferrous carbonate may be expected. Hot water services will be subject to extreme tuberculation as a result of the dissolved iron present in the natural water and not metallic corrosion. Actually, cause for replacements is not due to corrosion but to the high iron content clogging the services. Because all well waters are chlorinated, the water will also show traces of ferric chloride. Where elevated tanks are present, some dissolved oxygen will be absorbed, causing some precipitation of ferric oxide at the bottom of the tank and a "red water" condition. This type of water is found at Jewells Isle and Fort Kearney.

(4) Soft well water high in carbon dioxide with little or no oxygen

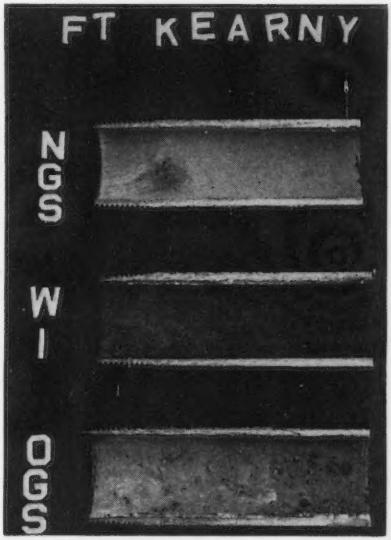


Figure 12—New galvanized steel (NGS), wrought iron (WI), and old galvanized steel (OGS) after treatment with hexametaphosphate 6 ppm.

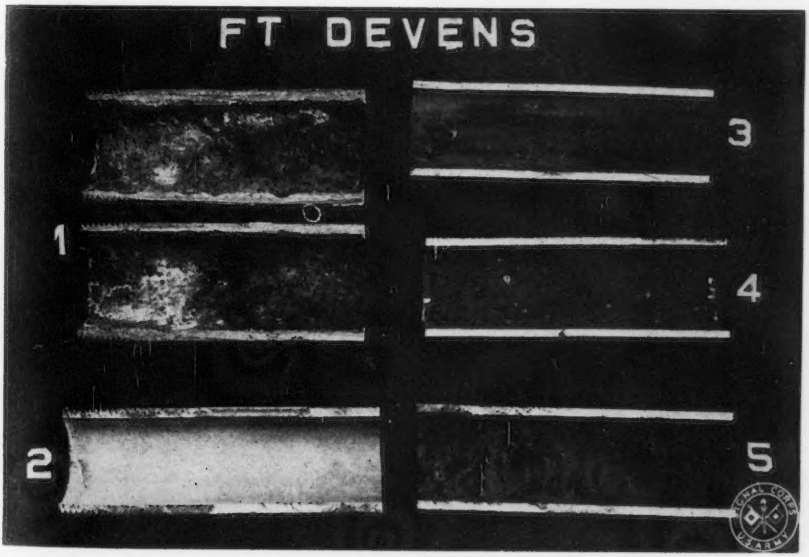


Figure 13—Specimen 1, after two years service in untreated hot water service; 2, cold water test nipple —lime-soda ash treatment; 3 and 5, hot water service, untreated; 4, cold water service, untreated.

present will prove slightly corrosive in cold water services. However, corrosion is considerably increased after chlorination. The initial hydrogen gas film on the pipe is broken by reaction with free chlorine. The products of corrosion are ferrous chloride and ferric chloride with no tuberculation present; the iron chlorides are carried through the system causing an ill-tasting and amber-colored water. Faucet leaks are very evident because of brass seats being "eaten" out. At posts with elevated storage tanks it was found that because of absorption of oxygen, pitting of hot water tanks, recirculating pipe, and heating coils was more acute than at posts with closed systems. This type of water is found at Fort Devens.

b. With Reference to Corrosion: Equilibrium in Very Soft Acid Waters

(1) The type and concentration of residual minerals in soft waters has a great bearing in determining the corrosiveness of these waters. Many waters which appear unaggressive by reason of being practically void of dissolved oxygen are still found corrosive when considerable quantities of chlorides, sulfates, or bicarbonates are present.

1) $2H^+ + 2e = H_2$ Hydrogen film
   $Fe - 2e = Fe^{++}$ Initial corrosion
2) $2H_2 + O_2 = 2H_2O$ Hydrogen film broken
   $H_2 + Cl_2{}^* = 2HCl$ Hydrogen film broken
3) $2HCl + Fe = FeCl_2 + H_2$
4) $Fe + 2H_2CO_3 = Fe(HCO_3)_2 + H_2Fe(HCO_3)_2 + 2NaCl = FeCl_2 + 2NaHCO_3Fe(HCO_3)_2 + Na_2SO_4 = FeSO_4 + 2NaHCO_3$

The presence of high sodium chlorides, sulfates and bicarbonates tend to increase the conductivity and consequently corrosion of these waters.

TABLE II

Calcium and Silver Saturation Residuals at Various pHs

pH	Calcium ppm	SiO_2 ppm
9.0	10.5	15.5
8.2	12.5	12.5
7.5	14.0	10.0
7.0	15.0	8.0
6.5	16.0	6.0
6.0	17.25	4.25

The best-suited method for stabilizing these ions is to increase the calcium and bi-silicate ion concentration. Calcium and silica saturation residuals at various pHs as determined through field water analysis are listed in Table II.

Soft waters having residuals as shown in Table II were found noncorrosive. On the basis of these findings, the "Casil Index"** was devised for determining the corrosiveness of soft water supplies.

Soft waters having negative indexes will be found very corrosive; indexes from 0 to + 0.10, slightly corrosive; indexes over + 0.10, noncorrosive.

The hexametaphosphate (unadjusted) treatment gave the best results with waters having low silica and calcium content. It was also better suited for highly tuberculated systems.

Corrosion decreased with the increase of water velocity.

All potable water treatments proved worthwhile in inhibiting corrosion.

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* All army water supplies were chlorinated (even purchased surface supplies).

** Casil Index $= \frac{Ca(epm) + Mg(epm) + HSiO_3(epm) - Anions(epm)}{2}$

epm—equivalent parts per million.

Conclusions

The more calcium present approaching positive Casil Indexes, the less silica required to obtain a deposition of silica on metallic surfaces.

A calcium silicate coating on water pipe offered the best protection.

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APPENDIX I

Types of Sodium Silicates

GENERAL CHEMICAL CO.

TYPE	BRAND	Na_2O Percent	SiO_2 Percent	Silicate Solids Percent	Gravity °Be	Mol Ratio*
1	Peak	8.6	27.9	36.5	41.5	1:3.25
2	Acme	8.9	28.7	37.6	40	1:3.32

PHILADELPHIA QUARTZ CO.

TYPE	BRAND	Na_2O Percent	SiO_2 Percent	Silicate Solids Percent	Gravity °Be	Percent Ratio*	Mol Ratio*
3	N	8.9	28.7	37.6	41.0	1:3.22	1:3.32
4	C	18.0	36.0	54.0	59.3	1:2.00	1:2.06
5	D	14.5	29.0	43.5	50.0	1:2.00	1:2.06
6	E	8.6	27.7	36.3	40.0	1:3.22	1:3.32
7	Matso Granular	29.3	28.7	58.0	....	1:02:1.0	1.15:1

* Ratio refers to $\frac{SiO_2}{Na_2O}$

APPENDIX II

Lime-Silicate Saturation to Achieve Positive Corrosion (Casil) Index

Example: CAMP EDWARDS

Raw Water	Condition	Casil Index	Langelier Index
Well B	Cor. Very	—.06	—4.35
Well E	Cor. Very	—.04	—4.47
Well G	Cor. Very	—.08	—4.43
Well J	Cor. Very	—.04	—4.14
Treated Water			
Pump Sta.	Cor. Not	+—.18	+0.2
Central 1	Cor. Not	+.20	+0.1
Central 2	Cor. Not	+.32	—0.9
Central 3	Cor. Not	+.28	—2.0
Central 3 (hot)	Cor. Not	+.15	—0.8
Dead-End	Cor. Not	+.14	—2.0

NOTE: Central 3 (hot) shows a decrease of 0.13 epm in the Casil Index. Chemical analysis at this position showed a deposition of 8 ppm SiO_2 and 1 ppm Ca., while the Casil Index showed a decrease of 4.7 ppm SiO_2 and 1 ppm Ca.

From past experience it is felt that an index of + 0.25 is desired to inhibit corrosion and form a protective film with this water. The initial index would depend mainly on the size of the post or length of the distribution system. For this post 0.25 epm of Ca $HSiO_3$ is required to bring the water to equilibrium and another 0.25 epm required to drop a coating on the pipe. This requirement can be divided between Ca and $HSiO_3$ in order to insure a $CaSiO_3$ coating.

How to Calculate a Calcium Silicate Dosage

Raw Well Water: pH 6.3, CO_2 20

	ppm	epm
Ca	8.0	0.40
Mg	2.5	0.21
SiO_2 (as $HSiO_3$)	5.2	0.08
	....	0.69
HCO_3	17	0.28
Cl	42	1.18
SO_4	20	0.42
	....	1.88

$$\text{Ca(epm)} + \text{Mg(epm)} + \text{HSiO}_3\text{(epm} - \frac{\text{Anions}}{2} = \text{Casil Index.}$$

Thus $0.69 - \frac{1.88}{2} = -0.25$

Calcium to be added: $\frac{0.25}{0.05}$

= 5 ppm = 9.3 ppm. Lime (95 percent)

Silica to be added: $\frac{0.25}{0.017}$

= 14.5 ppm = 52 ppm Sodium silicate (type 3).

CO_2 neutralized = 17 ppm.

Well waters having lower CO_2 values would have to be treated with more silicate and less lime or restrict the dosage to the CO_2 content.

Following is a table of dosages, expressed in ppm, all of which give the same Casil Index for this water.

Table of Dosages Expressed in ppm

CASE	Lime	As Ca	Sod. Silicate	As SiO_2	CO_2 Neutralized
1	9.3	5	52	14.5	17
2	14.8	8	21	5.9	21
3	18.0	9	10	2.9	23

Chimney Liner Corrosion Resulting From Gas-Fired Furnaces*

*By George B. Johnson**

CORROSION of chimney liners due to condensation in chimneys where gas is used as a fuel has been long a problem confronting the gas industry. With conflicting statements coming from both the field and the laboratory, much confusion can arise. Therefore, the intent of this article is to present data on our experiences with chimney lines to serve as a guide to anyone interested in the distribution of a similar type of gas.

Field Data Checked

As of December 31, 1946, Minneapolis and its suburbs had 41,720 installed heating jobs on its distribution system. This represents a saturation of about 30 percent and should provide enough field data to eliminate some of the conflicting statements concerning chimney liners.

Prior to 1936, the chimney flue, into which gas heating was vented, was sprayed with asphalt chromate emulsion. This was not satisfactory because adhesion was not good on dirty or wet surfaces. In 1936, Wilder metal, a copper-bearing steel with an aluminum oxide coating, was dipped in an asphalt chromate emulsion and used as a liner until 1939, when Wilder metal became scarce. Experimenting was done with a liner of vitreous enamel on steel in 1938, but because it chipped easily, this material was discarded. In 1938, plastic coating on steel was also tested: and was the principal material used through 1941. Because of the number of liners which were badly deteriorated, this was also discarded. In 1942 our company began to use 2-S½ hard aluminum exclusively until October, 1946, when a plastic coating on aluminum was used on the tee section and for the first section above the tee. In October, 1946, we began to receive complaints on the corrosion of the aluminum tees. It was suspected that the corrosion was being caused by some outside factor rather than flue gases, and therefore, the plastic coating was a temporary measure used to permit time for investigation of the cause. The investigation led to this survey and hence this report.

Since 1925, our company has kept a separate complaint file on house heat customers, into which every house heat complaint has been filed since the heating equipment was installed. We decided to make a sam-

★ A paper presented at the Annual Meeting of NACE in Chicago, Ill., Apr. 5-8, 1947.

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TABLE I

Sampling Accuracy

Year Ending	No. of H.H.* Units Analyzed and Failing in Same Year. (Cumulative)	No. of H.H.* Customers Taken From Meter Records. (Cumulative)	Ratio of Sampling to Actual No. of H.H.* Customers. (Percent)
1929....	5	239	2.1
1930....	6	281	2.1
1931....	10	462	2.2
1932....	13	491	2.7
1933....	15	496	3.0
1934....	25	646	3.9
1935....	43	1,180	3.6
1936....	77	2,030	3.8
1937....	145	4,335	3.4
1938....	258	7,636	3.4
1939....	393	11,542	3.4
1940....	593	15,347	3.9
1941....	784	20,101	3.9
1942....	800	21,804	3.7
1943....	808	21,788	3.7
1944....	860	23,559	3.7
1945....	1,024	28,991	3.6
1946....	1,262	41,720	3.0

* House Heating.

ple survey of approximately 3 percent of our 41,720 heating customers. An equal number of customer history records were pulled from each file cabinet. The total number pulled amounted to 1262. Every file pulled was then analyzed and tabulated according to installation year. Information tabulated on each installation was as follows: Type of heating equipment; type of liner; input; carbon dioxide; outside or inside chimney; stack temperature; other fuel vented into same chimney; and damage to chimney or liner.

Accuracy of Sampling

After tabulation was complete, the number of installations analyzed for each year was compared to the number of known heating installations taken from our meter records, in order to test the accuracy of our sampling. Table I gives the results of this comparison.

It will be noted in Table I that the percentage of sampling is low for the period of 1925 to 1933, which is probably due to the lack of installation records during the initial years of house heat installations. The period from 1934 to 1946 is quite constant. The low percentage for 1946 is due to our installation file being short 3000 1946 heating installation records, because we were that far behind in making orsat tests. (Customer installation record is not made up until orsat test on new installations is completed.) The 3000 shortage were practically all aluminum liner jobs.

Analysis of Various Liners

From 1925 to June, 1935, Minneapolis Gas Light Co. distributed manufactured gas of 520 Btu. This gas contained more total sulphur than the present mixed gas and no doubt had some effect on the deterioration of chimneys; however, the lack of proper chimney construction and liners is by far the greatest factor. A breakdown of the types of liners installed, calculated from the survey, is shown in Table II. In Table III, it is interesting to note that the percentage of damaged chimneys increased rapidly until 1935, when

TABLE II

Breakdown of the Types of Liners Installed (Calculated from Survey)

Chimneys without liners	4,720
Chimneys with Sewer Tile construction	8,410
Wilder metal coated with A.C.E.	5,185
Steel coated with plastic	9,200
Vitreous Enamel on steel	614
Transite	92
Payne liner (special jobs only)	213
Aluminum	13,800
Total	42,236
Total (from Meter Records)	41,720
Difference	516

The difference of 516 is due to chimneys without liners. In our survey, eighteen of these chimneys were damaged and subsequently lined, and appeared twice on our data sheets (18/1262 x 38,720 = 551).

TABLE III

Analysis of Heating Installations without Chimney Liners

YEAR INSTALLED	Number of Installations Analyzed	EQUIPMENT*				Number of Reported Chimneys Damaged	Ratio of Number of Damaged Chimneys to Number of Installations (Percentage)
		Conv.	G. D.	H. W.	W. A.		
1928	1	0	1	1	0	0	0
1929	2	0	2	1	1	0	0
1932	1	0	1	1	0	0	0
1933	1	0	1	1	0	0	0
1936	1	0	1	0	1	0	0
1937	4	2	2	3	1	1	25.0
1938	3	2	1	1	2	1	33.3
1939	0	0	0	0	0	0	....
1940	8	8	0	4	4	5	62.5
1941	18	14	4	10	8	6	33.3
1942	18	10	8	10	8	4	22.2
1943	7	3	4	2	5	0	0.0
1944	10	3	7	6	4	1	10.0
1945	13	2	11	5	8	0	0.0
1940	10	5	5	3	7	0	0.0
1941	10	2	8	1	9	0	0.0
1942	1	0	1	0	1	0	0.0
1943	1	1	0	1	0	0	0.0
1944	8	4	4	4	4	0	0.0
1945	19	12	7	11	8	0	0.0
1946	18	12	6	9	9	0	0.0
Total....	154	80	74	74	80	18	
Percent...		52	48	48	52	11.7	

* Conv.—Conversion burner. G. D.—Gas designed. H. W.—Hot water boilers.
W. A.—Warm Air Furnaces.

the City of Minneapolis passed the first ordinance requiring proper chimney construction and corrosion-resistant liners for gas-fired heating installations. The number of damaged chimneys immediately decreased, and in the last eight years they have been practically nil.

City Gas-Heat Code

The city gas heating code calls for a glazed bell joint sewer tile to be used in new construction. The tile must be installed with the bell joints up and an acid-proof cement must be used in its construction. Table IV shows the results of using sewer tile for gas-fired heating installations.

The use of sewer tile was confined mostly to the construction of new houses. The damaged chimneys reported during the heavy construction years were due mostly to builders trying to circumvent restrictions by using ordinary unglazed butt-tile. There has been no damage reported since 1941.

Asphalt chromate coating on Wilder metal was the principal liner used throughout 1938. Of approximately 5000 of these liners installed, only about 200 have had to be replaced, which means that we have 4800 still in use, the majority of which have been in service ten years. The largest number of these liners were installed in 1937 and, accordingly, the highest percentage of damaged liners are from among those installed that year. This may indicate that some of the liners were damaged through faulty installation, because asphalt chromate emulsion becomes sticky in warm weather, and on contact with other surfaces is apt to be pulled off. The discard-

TABLE IV

Analysis of Heating Installations Using Sewer Tile

YEAR INSTALLED	Number of Jobs Analyzed	EQUIPMENT*				Number of Reported Chimneys Damaged
		Conv.	G. D.	H. W.	W. A.	
1936	2	2	0	2	0	0
1937	..	0	0	0	0	0
1938	18	1	17	6	12	0
1939	49	3	46	4	45	1
1940	100	2	98	1	99	4
1941	77	1	76	5	72	1
1942	3	1	2	0	3	0
1943	5	0	5	0	5	0
1944	4	3	1	2	2	0
1945	2	0	2	1	1	0
1946	14	1	13	0	14	0
Total	274	14	260	21	253	6
Percent		5.1	94.9	7.7	92.3	2.2

* Conv.—Conversion burner. G. D.—Gas designed. H. W.—Hot water boilers.
W. A.—Warm air furnaces.

ing of this material was due to scarcity of Wilder metal and the meanness of its handling. Table V shows that there has been very little replacement of this type liner installed since 1937.

The next principal liner used was a plastic-coated liner on steel. More than 9000 of these liners have been installed. What happened to this type is shown in Table VI. Prior to the use of this liner, extensive laboratory tests were run and results revealed this coating more resistant to corrosion than any other. However, Table VI shows that this liner fared worse than any of the others under actual field conditions. We have replaced about 1500 of these liners, mostly because of failures along seams and around screw holes. Later laboratory tests revealed that if a scratch or small pin hole was obtained through the plastic coating,

TABLE V

Analysis of Heating Installations Using Wilder Metal Dipped in Asphalt Chromate Emulsion (ACE)

YEAR INSTALLED	Number of Jobs Analyzed	EQUIPMENT*				Number of Chimney Liners Reported Damaged
		Conv.	G. D.	H. W.	W. A.	
1935	3	3	0	2	1	0
1936	17	13	4	11	6	0
1937	63	56	7	37	26	6
1938	42	41	1	24	18	0
1939	5	2	3	4	1	0
1940	14	14	0	12	2	1
1941	1	0	1	0	1	0
1942	2	2	0	0	2	0
1943	1	1	0	1	0	0
1944	13	7	6	5	8	0
1945	8	2	6	2	6	0
1946	0	0	0	0	0	0
Total	169	141	28	98	71	7
Percent		83.5	16.5	58	42	4.1

* Conv.—Conversion burner. G. D.—Gas designed. H. W.—Hot water boilers.
W. A.—Warm air furnaces.

TABLE VI

Analysis of Heating Installations Using Plastic Coating on Steel Liner

YEAR INSTALLED	Number of Jobs Analyzed	EQUIPMENT*				Number of Chimney Liners Reported Damaged
		Conv.	G. D.	H. W.	W. A.	
1938	44	32	12	19	25	14
1939	70	59	11	41	29	22
1940	71	50	21	33	38	11
1941	101	65	36	31	70	4
1942	10	7	3	3	7	0
1943	2	1	1	1	1	0
1944	1	1	0	1	0	0
1945	0	0	0	0	0	0
1946	1	1	0	0	1	0
Total	300	216	84	129	171	50
Percent		72	28	43	57	16.7

* Conv.—Conversion burner. G. D.—Gas designed. H. W.—Hot water boilers. W. A.—Warm air furnaces.

acid would work its way underneath the coating, disintegrate the steel and peel off the coating. A large number of these liners were also damaged because incinerators, etc., were being vented into the same flue. In this case, hot gases from the incinerator would burn off the coating, exposing the base metal. It is for this reason that we now discourage having appliances using fuels other than gas vented into the same liner.

It is interesting to note in Tables V and VI that the highest percentage of damaged liners are in the years that had the highest percentage of hot water boilers, a condition which we attribute to the low stack temperature developed in this type of boiler.

The use of aluminum liners was started in 1944. At present there are over 13,000 of these liners installed. The first complaints of damaged liners were received in the fall of 1946. We became alarmed, and instituted a thorough investigation of all damaged liners. Results of this investigation are shown in Tables VII and VIII.

A study of Table VIII reveals the following:

1) All inside corrosion of liners occurred in converted hot water boilers.

2) The majority of corrosion resulting from the inside occurred at

TABLE VII

Analysis of Heating Installations Using Aluminum Liners

YEAR INSTALLED	Number of Installations	EQUIPMENT* (Percent)				Number of Liners Reported Damaged
		Conv.	G. D.	H. W.	W. A.	
1944	736	79	21	50	50	5
1945	3,740	77	23	56	44	16
1946	9,220	87	13	42	58	4
Total	13,696	83	17	48	52	26

* Conv.—Conversion burner. G. D.—Gas designed. H. W.—Hot water boilers. W. A.—Warm air furnaces.

TABLE VIII

Analysis of Aluminum Liner Damage

Date Installed	Date Checked	Type of Furnace	Stack Temp.	Water Heater Vent	Previous Fuel	Repairs to Chimney	Location of Damage to Liner
Aug. '44	1-27-47	Grav, HW, Conv.	330	Side Arm	Briquets	None	Bottom of tee gone from inside.
Sept. '44	11- 7-46	Grav, HW, Conv.	370	Inside Liner	Soft Coal	None	Tee corroded. Replaced.
Nov. '44	11- 7-46	Grav. HW, Conv.	380	Outside Liner	Soft Coal	None	Tee corroded. Replaced.
Nov. '44	11-22-46	Grav, HW, Conv.	380	Inside Liner	Soft Coal	None	Tee corroded. Replaced.
Dec. '44	11- 7-46	Grav, HW, Gas Dsgn.	370	Outside Liner	Soft Coal	None	Slight discoloration and roughness all the way up.
Dec. '44	11- 7-46	Grav, WA, Conv.	500	Outside Liner	Soft Coal	None	Good condition. No damage.
Jan. '45	11- 8-46	Forced, WA, Gas Dsgn.	500	Outside Liner	Soft Coal	None	Good condition. No damage.
Feb. '45	11- 8-46	Grav., WA, Gas Dsgn.	440	Outside Liner	Soft Coal	None	Good condition. No damage.
Apr. '45	11- 8-46	Steam, Conv.	330	Inside Liner	Coke and Soft Coal	None	Good condition. No damage.
Apr. '45	11- 7-46	Grav, WA, Gas Dsgn.	440	Outside Liner	Soft Coal	None	Good condition. No damage.
Jan. '45	11- 8-46	Forced, WA., Gas Dsgn.	400	Inside Liner	Coke	None	Good condition. No damage.
Apr. '45	1-27-47	Grav, HW, Conv.	550	Auto. Outside Liner	Soft Coal	None	Tee gone from inside at bottom.
Apr. '45	1-22-47	Grav, HW, Gas Dsgn.	400	Auto. Outside Liner	Soft Coal	None	Tee and joints had hole from outside. Outside all pitted.
*May '45	11- 9-46	Grav, HW, Conv.	300	Outside Liner	Stoker Coal	None	Tee completely gone. Joints corroded at seam. Replaced complete.
June '45	Mar. '47	Forced Air, Gas Dsgn.	445	20 gal. auto. Outside Liner	Soft Coal	None	Tee damaged. Soot on outside starting corrosion on each joint.
May '45	Mar. '47	Grav, WA, Conv.	500	None	Soft Coal	None	Tee damaged. Soot sump from outside.
July '45	11- 7-46	Grav, HW, Conv.	310	Outside Liner	Coke	None	Tee corroded. Replaced.
*July '45	11- 9-46	Grav, HW, Conv.	290	.....	Soft Coal	None	Tee corroded. Replaced.
July '45	3- 4-47	Grav, WA, Gas Dsgn.	420	Side Arm, Outside Liner	Soft Coal	None	Tee corroded from outside. Soot laying on horizontal piece.
July '45	3- 4-47	Grav, WA, Conv.	470	Side Arm, Outside Liner	Soft Coal	None	Small hole on horizontal part of tee from outside.
July '45	3- 6-47	Grav, WA, Conv.	450	Rex auto. Outside Liner	Soft Coal	None	Deterioration on side of tee from outside. Soot piled up around tee.
Aug. '45	Nov. '46	Grav, HW, Conv.	390	Outside Liner	Coke	None	Tee corroded. Replaced.
Sept. '45	3-47	Grav, HW, Conv.	350	None	Soft Coal	None	Bottom of tee gone. Setting down in soot sump.
Sept. '45	11- 7-46	Grav, WA, Conv.	410	Inside Liner	Soft Coal	None	Tee corroded. Replaced.
Oct. '45	1- 3-47	Grav, HW, Gas Dsgn.	390	No heater	Soft Coal	None	Tee damaged from outside. Soot piled up around same.
Nov. '45	11- 7-46	Grav, HW, Conv.	280	Outside Liner	Carbon Coke	None	Tee corroded. Replaced.
No. '45	1-27-47	Grav, HW, Conv.	320	Auto. Inside Liner	Soft Coal	None	Tee gone from outside. Piled up with soot.
Jan. '46	11- 9-46	Grav, HW, Conv.	340	Inside Liner	Soft Coal	Top rebuilt; Chimney capped.	Tee corroded. Some joints starting. Replaced.
Feb. '46	1- 7-47	Grav, HW, Conv.	360	Outside Liner	Soft Coal	None	Tee coroded from inside. Replaced
Feb. '46	3-27-47	Grav, HW	400	Side Arm Outside Liner	Carbon Coke	None	Complete liner damaged from outside. Liner touching tile at numerous spots in chimney.
Feb. '46	3-27-47	Grav, HW, Conv.	340	2 auto. Outside Liner	Soft Coal	None	Removed liner. Coal furnace vented outside liner.

the bottom of the tee, and was due to foreign material on the bottom, or to condensate lying in the bottom of the tee. (Tee drain located 2 inches above bottom to avoid plugging.)

3) Corrosion from the outside was caused by soot around the tee; tee resting on iron pipe, or from aluminum coming in contact with mortar.

Scale Checked in Laboratory

As mentioned before, on the first complaints we replaced the tee sections with a plastic-coated aluminum to offset the corrosion resulting from foreign material. On two installations, marked with asterisks in Table VIII, it will be noted that severe corrosion took place on new installations two months after the heating season started. These boilers had not been cleaned at the time of installation. Suspecting that the corrosion was due to scale and other accumulations, the boilers were cleaned thoroughly and the corroded sections replaced with new aluminum. Inspection of these two boilers the latter part of March, after four months of service through the severest part of the winter, revealed the replaced sections as good as new.

A sample of the scale cleaned from these boilers was sent to the Aluminum Company Research Laboratories for analysis, and Mr. Dix, Assistant Director of Research, reported the following:

"Spectographic and chemical analyses were made of the scale. The former showed that the major metallic constituent was iron. Aluminum was detected in rather appreciable amounts, and in small amounts were manganese, titanium, chromium and molybdenum listed in order of decreasing concentration. Other metallic constituents detected were present in insignificant amounts.

"Chemical tests disclosed that a water leach of the scale had a pH (at 25°C) of 5.8 and contained 0.25 percent water soluble chlorides and 1.1 percent soluble sulfates. These tests were made on a one gram sample treated with 100 ml of boiling distilled water. No analysis was made of the carbonaceous constituents that apparently existed in the sample of scale.

"Accelerated corrosion tests were also conducted to determine whether the scale would stimulate corrosion of aluminum under warm moist conditions. For this test, we immersed a sample of 3S aluminum alloy in a thick layer of scale particles, added 10 ml of distilled water to moisten the scale, and then exposed the unit to 100 percent relative humidity at 125°F. An inspection of this sample after an exposure of one week showed that the aluminum had been appreciably pitted at local areas. This suggests that the scale might have been a contributing factor with regard to the corrosion of flue liners encountered in service providing, of course, that particles or constituents from the scale had been carried over to the flues in rather appreciable amounts, as we do not think that very small amounts would, in themselves, have any really deleterious effects."

Summary

A study of the Battelle Memorial Institute Literature Review Report[1] to the American Gas Association on "Corrosion and Deterioration of Met-

als and Materials Under the Influence of Products of Combustion of Gaseous Fuels" reveals that the magnitude of corrosion problems are in direct proportion to the oxides of sulfur formed during combustion. It has been assumed that the sulfur is first oxidized to SO_2 (sulfur dioxide) and then partially oxidized to SO_3 (sulfur trioxide). Various authorities state that the formation of sulfurous and sulfuric acid in the condensate depend on the ratio of SO_3 to SO_2 and that the dew point is effected considerably by the SO_3/SO_2 ratio. High SO_3/SO_2 ratios increase the dew point and also increase the concentration of $H2\ SO_4$ (sulfuric acid) and $H2\ SO_3$ (sulfurous acid) in the condensate. H. F. Johnstone[2], in his paper, An Electrical Method for the Determination of Dew Point of Flue Gases, found that a difference of .008 percent in the SO_3 content resulted in a difference of 125°F. in dew point temperature.

Laboratory Analysis

I believe that we can assume that in burning a gaseous fuel of constant total sulfur in an atmospheric burner that the concentration of SO_3/SO_2 will remain fairly constant, and, therefore, the magnitude of corrosion will vary according to the stack temperature and dilution of stack gases. An analysis of our damaged liner reveals the following:

1. Average stack temperature on ACE damaged liners was 310°F. (Majority of installations are conversion.)
2. Average stack temperature on plastic-coated liners was 330°F., on hot water boilers and 380° F., on warm air furnaces. (Majority of installations are conversion.)
3. Average stack temperature on aluminum liners was 360°F., on hot water boilers and 450°F., on warm air furnaces.

The average stack temperature of all installations in Minneapolis is 380°F., although higher stack temperatures were encountered in the case of corroded aluminum liners, the writer believes most of the corrosion was caused by factors other than the sulfur in the gas, as Table VIII reveals.

Studies Continued

In the case of ACE and plastic coated liners, there were stack temperatures up to 400°F. in a few instances, but it is believed that poor draft conditions, preventing proper dilution of flue gases or other corrosion products resulting from the previous fuel consumed, caused corrosion to take place. Time did not permit determination of this, but it is our hope to continue a study along these lines.

This fall Minneapolis Gas Light Co. expects to distribute straight natural gas to consumers. In this case, the natural gas will contain 0.5 grain total sulfur (including odorant) compared to 2.5 gr /100 cu. ft. in our present mixed gas. This is a reduction of 80 percent in sulfur content; and from our foregoing study, it is believed that it may be possible to vent flue gases without a liner, if the flue stack temperature is kept at 400°F. and above and the furnace boiler is well cleaned at the time of installation. If poor draft conditions are encountered, a stack

temperature of 450°F. is recommended. The raising of stack temperature to 400°F. would result in about a one percent decrease in efficiency to our average customer, which in dollars and cents amounts to about eighty cents per year. In the case of 450°F., stack temperature, the decrease in efficiency would be about four percent, or $3.20 per year.

For the present, until the above can be proved by actual field tests, we will continue using aluminum, since evaluating the three major types of liners, used to date, according to the number installed and the number of years each type has been in service, it appears that aluminum is standing up the best. It is the writer's opinion that installed properly in a clean furnace or boiler and without touching any mortar or iron, the aluminum liner will last indefinitely (22-gage aluminum).

We have been frequently asked, "How about the use of aluminum for manufactured gas?" Manufactured gas contains a great deal more total sulfur than our gas, and therefore, we hesitate to answer this question. Wood and Parrish[3], in their report on Corrosion From the Products of Combustion of Gas, show that the corrosion of aluminum from sulfur content of gas increased up to a sulfur content of 4 grains per 100 cu. ft. and that further increases of sulfur content had very little effect. If this is true, it is the writer's opinion that aluminum liners used in manufactured gas areas have a good chance of being successful.

Acknowledgments

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Utilization of Electrically Insulated Couplings in Corrosion Control*

*W. F. Levert**

IT IS THE PURPOSE of this article to present a brief discussion regarding practical uses, methods of installation, and benefits derived from insulating couplings. Many corrosion engineers have long recognized that certain benefits can be realized by intelligent use of insulated couplings, but because of the tedious detail work involved, especially on large systems, many have delayed taking advantage of this useful tool. It is hoped that the following discussion will be helpful to those persons who are encountering corrosion problems that can be effectively retarded by use of insulated couplings.

Advantage of Isolation

By means of insulated couplings, certain sections, large or small, on transmission, gathering, or distribution systems can be easily and effectively electrically isolated from connecting metallic structures. Such isolation facilitates periodic coating-resistance tests, which are of utmost importance when pipelines are buried in highly corrosive soils. In addition, it is often desirable to electrically isolate a section of a pipeline system so that cathodic protection can be effectively and economically applied. Very often only a small section of a pipeline lies in an extremely corrosive soil; and in order to concentrate drainage currents on this anodic or corrosive section, insulating couplings can be employed. This eliminates the extra and unnecessary amount of electrical energy which would be required if the anodic sections were not insulated from adjacent metallic structures not in immediate need of cathodic protection.

Break Long Line Currents

Long line currents very often have been greatly detrimental to the life of a buried metallic structure, especially in pipelines. Application of insulated couplings at various locations along a system sometimes has been effective in breaking up or reducing long line currents.

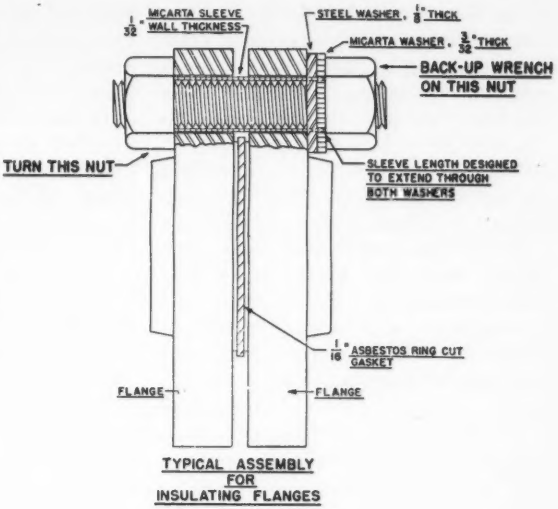
Through experience alone the corrosion engineer has learned just what methods of installing insulating materials are the most effective and practical.

Not too long ago, it was common

★ A paper presented at the First Annual Meeting of the South Central Regional Division of NACE in Houston, Texas, Oct. 26-27, 1947.

* United Gas Pipe Line Co., Shreveport, La.

practice, when insulating flanges, to replace the standard size bolts with bolts of smaller diameter and higher tensile strength to permit the use of an insulating sleeve of 1/16-inch wall. Such procedure required special bolts, which was an additional cost above that of the insulating materials. In the case of raised faced flanges, ¼-inch and ⅛-inch thick, micarta and bakelite gaskets were used. In some cases, these gaskets were faced with 1/16-inch asbestos, which did not always provide a satisfactory seal, particularly in large diameter flanges. The insulating washers, in many cases, were not suitable because the insulating assembly was in the experimental stage, and had not been satisfactorily designed.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FLANGE
TYPICAL ASSEMBLY FOR INSULATING FLANGES

FIGURE 1

Standard Bolts Used

Today, engineers do not find it necessary to deviate from the standard size bolts and flanges in order to insulate. A micarta insulating sleeve, preferably linen base, 1/32-inch thick, is used to insulate the standard bolts from the flange without having to enlarge the standard size bolt holes of the flange or purchase smaller bolts. A standard size ring cut gasket, generally of asbestos 1/16-inch thick, is used. This type of gasket, similar to that which is in common use, not only separates flange faces electrically, but definitely provides a satisfactory seal and easily withstands the pressure imposed upon it by the tightened flanges. To insulate nuts from contact with the flange, micarta washers, with a minimum compressive strength of 36,000 pounds per square inch, and with an inside diameter to give a snug fit when slipped over the insulating bolt sleeve, are used. The outside diameter of this washer is designed so that it will not extend beyond the rim or hub of the flange. To avoid having the micarta washer shear along the edges of the flange bolt holes, a steel washer, with the same inside and outside diameter as that of the micarta, is used. This steel washer is slipped over the micarta sleeve and rests between the steel washer and nut as illustrated in Figure 1.

The question is sometimes raised

regarding the dielectric or insulating qualities of the standard 1/16-inch ring cut gasket. For this reason the following laboratory test has been carried out. A 2-inch, Series 300, raised face flange was insulated, using the above described insulating materials. With a plain asbestos gasket, 1/16-inch thick, 18 volts dc were impressed across the flange face. At this potential, 3.0 microamperes were measured. An ac voltage was then impressed across the flange, and gradually increased to 960 volts. There was no arcing of flanges up to this voltage. A second flange was then insulated, using a 1/16-inch asbestos gasket, with graphite on one side. With 18 volts dc impressed across this flange, 0.10 microampere were noted. No arcing resulted with 960 volts ac impressed. Current measurements were not made during applications of ac voltages.

Breakdown Test

The two above flanges, fully insulated, and with their respective type of gaskets, were then soaked in a salt-water solution (15,000 ppm) for 16 hours, removed, air blown, and allowed to dry in atmosphere for three hours. Eighteen volts dc were then impressed across the flange with the plain asbestos gasket, and 94 milliamperes were measured. This flange shorted out when 125 volts ac were reached. With 18 volts dc across the second flange of asbestos gasket with graphite on one side, 28 milliamperes flowed. The second flange shorted out at 150 volts ac.

A visual inspection of the insulating materials revealed that one insulating sleeve from each of the two flanges shorted out at one spot on the edge of the sleeve next to the steel washer.

It has always been our standard practice to coat and wrap all underground or submerged insulated couplings.

Snug Fit Required

To assure a snug fit of washers to tubing, rigid specifications are required. Snug fit of washers provides a means of eliminating the possibility of the insulating tubing freeing itself from the washers and allowing the bolt to contact the flange on the insulated side. A more detailed discussion regarding material specifications, mechanical strength, design, and method of installation is presented in a companion paper reproduced in this issue of CORROSION. Investigations are being made as to the possibility of using a washer of insulating material which can withstand the compression and shearing stresses to which it is subjected, in order to eliminate steel washers.

It is now standard practice with us to insulate one flange of all valves along transmission and gathering systems.

Example of Isolation

One of our major insulation projects was begun approximately two years ago. This undertaking covered the large Carthage, Texas, Gas Field. One hundred forty-two miles of 24-inch transmission pipe were insulated into 32 electrically isolated sections, which included five sections of river crossings. Seventy-six miles of gas gathering system, consisting of 6-inch, 8-inch, 10-inch,

12-inch, 16-inch and 20-inch pipe, were insulated into 91 electrically isolated sections. Because the entire system, both transmission and gathering, is operated at relatively high pressures, it was deemed necessary to reduce the possibility of existing long line currents and at the same time provide an effective means for making periodic coating resistance tests. This project also made it possible to install cathodic protection on any or all of the isolated sections if and when needed.

Long Line Currents

We have long known and realized that long line currents, originating from a battery action between our gathering systems and oil or gas wells, have been discharging into well structures, with most of this current discharging from the casing. With an electrical consumption of 20 pounds per ampere year occurring on the casing and probably the tubing of such wells, this certainly is a serious problem.

For several years we have wanted to insulate all well structures from connecting gathering ystems by insulating at the tubing and casing wing valves or flow lines immediately adjacent to the christmas tree. Preference was given to insulating at the wing valves.

Insulating Problem

Because of the pressures generally encountered in oil and gas fields, most flanged connections were, and are, of the ring-groove type, employing a metal ring gasket. Such a gasket made it almost impossible to insulate. Only recently a dielectric ring gasket has been available to replace the metal ring commonly used on oil and gas well equipment. This new dielectric ring has sufficient mechanical strength, in excess of 60,000 psi compression, to withstand field pressure or extreme tightening. The ring is unaffected by liquids and gases encountered in oil and gas systems. It is easy to install, in that the ring will seat and seal with less tightening than is required by the regular steel ring, and eliminates galvanic action between flange and ring, which is usually prevalent when using steel rings.

Effect Great Savings

About 15 months ago we started a program of insulating all well structures from adjacent gathering systems. A survey was made to determine just what insulating materials would be necessary to complete this program. At the time of the survey, long line currents were measured along each flow line connected to each well. Measurements made at 383 wells showed a total of 380 amperes flowing, and in all cases current was flowing along the gathering lines into the wells. On the basis of the loss of 20 pounds of iron per ampere per year we saved approximately 7660 pounds of casing material per year by insulating the connecting flow lines from these wells. In one field, measurements were made at 34 wells where 128 amperes were flowing. Currents ranged from a maximum of 11.65 amperes to a minimum of 0.81 ampere.

In another field, measurements were made at 59 wells, with a total of 62 amperes being measured. The current ranged from a maximum of

2.0 amperes to a minimum of 0.11 ampere. Two casing failures were experienced approximately two years prior to the insulation of well structures from the connecting gathering system. In view of the magnitude of current being discharged into these wells, prior to insulating, it was reasonable to assume that these discharging currents played an active part in these casing failures.

It is common practice with some engineers when insulating wells from connecting gathering systems, to insulate at the meter run. In practically all cases the lines from the christmas tree to the meter run are underground. It is entirely possible that a battery action between well structure and flow line can exist, even though only a small section of the flow line is buried. For this reason, we recommend insulating flow lines from the christmas tree at the wing gates wherever possible, or on the flow lines above ground next to the christmas tree. When insulating wells from gathering systems, it is important to insulate all wells in the same system in order to eliminate the possibility of increasing the current flow into uninsulated ones.

Because the installation of insulating materials has proved to be such an important and necessary factor in combating and arresting corrosion, it is advanced that consideration should be given the possibility of standardizing installations. Such standardization would not only assure a satisfactory means of properly accomplishing the job of insulation for all concerned, but would probably result in mass production of the necessary materials, thereby making them more economical.

Mechanical Design Features of Insulated Couplings*

*By Paul Williams**

GENERAL DESIGN features of insulated steel flanges, outlining the objectives and giving the reasons for dimensional controls are briefly outlined in this article. No attempt is made to establish the insulating effectiveness of the assembly because the subject is covered in the preceding article reproduced in this issue of CORROSION.

In addition to securing high quality insulating characteristics, the general design objectives have been safety, durability, adaptability and low cost.

Safety

The assembly must present no undue hazards either during or after installation. The micarta washer illustrated in Figure 1, which has a compressive strength of 36,000 pounds per square inch, is the only element of the assembly which can be considered hazardous; when washers are compressed to destruction in laboratory tests, the material changes from a solid to a granular or powdered substance with part of it escaping while some of it remains too compact to serve as a thinner insulating washer. Failure will not occur unless the flange bolts are excessively loaded beyond their recommended operating stress. Insulating washers have been designed as thin as is consistent with the requirement that they possess some rigidity and that they be able to withstand shipping, handling, and installing.

No danger results from failure of sleeves. Metal washers are stronger in compression than the flange bolts are in tension because of the relative areas under stress. The conclusion to be drawn is that the assembly in general does not constitute a safety hazard unless flange bolts are grossly overloaded, in which case the hazard would exist in any flange assembly, whether insulated or not.

Durability

The assembly must be durable, require no attention after installation and have a long service life. Our experience is limited here, but it is believed that the long service life of micarta products under more severe conditions is a favorable indication to long life as a part of these installations.

★ A paper presented at the first Annual Meeting, South Central Regional Division of NACE in Houston, Texas, Oct. 26-27, 1947.

* United Gas Pipe Line Co., Shreveport, La.

Adaptability

It should be possible to install the materials on flanges already in service and under pressure, without providing special gaskets, supplying longer or smaller diameter bolts or redrilling and spot facing flanges.

The assembly can be installed by removing one flange bolt at a time, placing the insulating elements on it and reinstalling before loosening the next bolt. Care should be exercised when installing a complete insulated flange assembly. The flange faces should be properly aligned, and after inserting the insulating gasket, should be tightened together with two diametrically opposed *uninsulated* bolts. The remaining bolts should then be completely insulated, inserted in bolt holes and tightened uniformly. The two uninsulated bolts should then be removed, insulated, and tightened to complete the assembly. This procedure is recommended to prevent damage to the insulating sleeves.

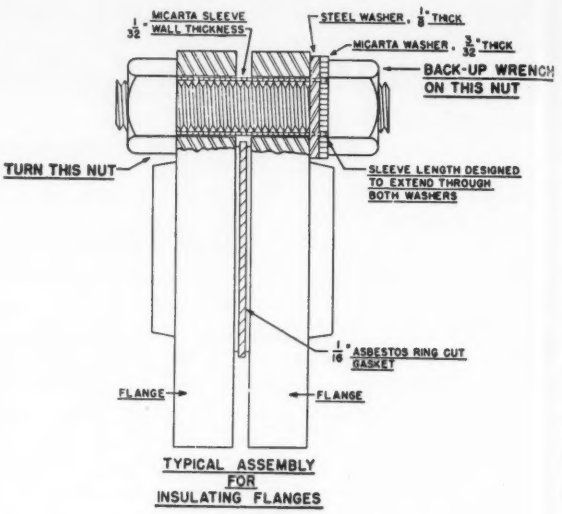
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FIGURE 1

Low Cost

The assembly should be inexpensive without sacrifice to safety or performance. To this end the parts should be small and made of common materials; manufacturers' tolerances should be as generous as possible and in order to reduce warehouse stocks, the number of parts required to insulate all flange sizes and pressure ratings should be low. In this connection, the assembly illustrated in Figure 1 is designed so that the outside diameter, the inside diameter and the thickness of sleeves and washers are dependent on the diameter of the bolts, and are not specifically concerned with flange size or working pressure. For example, all flanges using one-inch bolts have the same washers, the only difference being in the length of the bolt sleeve.

After selecting materials believed to fulfill the foregoing general design requirements, dimensions and tolerances were specified, most of them being obvious. For example, the outside and inside diameters and the wall thickness of sleeves are largely controlled by ASA code dimensions and tolerances for bolts, flanges and flanged fittings. Sleeve wall thickness is 1/32-inch, making

the outside diameter 1/16-inch greater than the outside diameter of the bolt and 1/16-inch less than the bolt hole diameter. The 1/16-inch clearance through the bolt hole is necessary to allow for misalignment of holes in pairs of matching flanges, resulting from the manufacturers' tolerance in spacing of flange bolt holes. All-thread stud bolts should be used as manufacturers' gauges to obtain snug fit of micarta sleeve on bolt. Sleeves should be used as manufacturers' gauges to secure a snug fit of both micarta and steel washers on sleeve.

The OD of washers is slightly less than the dimensions of spot facings on the back face of flanges, being sized to fit inside such facings, to furnish a flat bearing surface normal to the bolt axis. Washers overlap the flange bolt holes, imposing shear stresses in the washer at the edge of the bolt hole. Thin micarta washers now in use are not strong enough in shear to withstand such stresses. The presently used micarta washer, if sheared at the edge of the bolt hole, will be forced inside the bolt hole against the insulating sleeve, causing severance of the sleeve. Should the micarta washer be thick enough to withstand this shearing at normal loading, abnormal loading of the bolts would result in a compression failure of the washer. Due to the washer thickness, this failure could possibly cause an abrupt excessive strain on the remaining materials, resulting in a mechanical as well as an insulation failure. Steel washers are therefore provided underneath the micarta washer to withstand shear and relieve present micarta washers of all but compression stress. However, dielectric materials are now under development which have high shear value; and if they meet expectations, metal washers may be eliminated entirely.

For those concerned, a schedule of dimensions and tolerances for insulation materials is listed below:

Sleeves

1) 1/32-inch thick.

2) All sleeve lengths to be 3/16-inch greater than the distance between outside faces of assembled flanges.

3) Tolerances:

a. Sleeves are designed to slip over all-thread bolt; snug fit.

b. Thickness $\pm$ 0.001-inch.

Washers

1) Micarta 3/32-inch thick.

2) Steel 1/8-inch thick, cut from rolled steel plate.

3) The OD of all washers to be slightly less than the code dimensions for spot facing steel flanges.

4) Tolerances:

a. Inside diameter — washers are designed to slip over sleeves; snug fit.

b. Outside diameter $\pm$ 0.016-inch.

Recent Developments in the Use of Corrosion Inhibitors*

*By Jay T. Nicholson**

IN THE ART of treating and conditioning water, and fluids containing water, there has been a very marked improvement in the use of corrosion inhibitors, but the problem never seems to end. It is the purpose of this discussion to focus attention on some of the latest methods of evaluating factors causing corrosion, and recent developments in the use of chemical inhibitors. No attempt is made in such a short discussion to comprehensively cover the entire field of corrosion.

The importance of corrosion prevention and the need for careful examination of the various manifestations of corrosion occurrence in plant operating equipment is paramount. The present loss of literally millions of dollars worth of plant equipment through avoidable corrosion attack can be prevented by careful evaluation of the corrosion factors involved and subsequent correct recommendations for protective treatment and mechanical practices.

Simple tests for the classification and evaluation of the efficiency of these chemical treatments and mechanical practices in corrosion prevention are desirable. However, corrosion is produced by such a large number of factors that up to the present time a simple laboratory test for this purpose has not been devised that will give trustworthy information to be transferred or extrapolated to field problems. Thus when only simple laboratory tests are made it is only possible to say that "under these conditions, these results were found."

Factors which cause corrosion act both individually and interdependently, and fall into one of the three following general classes:

1) Those present in water, such as chlorides, sulfates, nitrates, dissolved gases, pollution, etc.

2) Those present in the environment, such as flow rate, temperature, and concentration of anodic-cathodic areas by differential areation, differential temperatures, coupling of dissimilar metals, or by application of stray and uncontrolled electric currents.

3) Types and dosage of chemical treatment for corrosion prevention. Thus the greatest problem in any corrosion study research is the duplication of actual operating conditions in the laboratory set-up. When this is not completely accomplished, the transfer of any conclusion to actual field tests must be made cautiously, and it is on this point that the

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★ A paper presented at the NACE Western Regional Division meeting in Los Angeles, Calif., June 4, 1947.

* District Manager, National Aluminate Corp., Los Angeles, Calif.

greatest difficulty is usually experienced.

Many tests do not take into account any change in the physical or chemical condition of the protective material added, which might be caused by oxidation or chemical change during the test run. Unless these variables are closely controlled, results may be so varied as to be unexplainable; so that trends are not evident, or may be completely reversed from that which would be experienced in the plant under field operating conditions.

Simple Test Method

A simple method which has been used extensively is that of rotating metal specimens immersed in water solution containing the protective chemical. Specimens, usually mild steel, (10-20 hot rolled) are revolved at rates which would give a flow of water past the metal corresponding to estimated flow-rates in pipelines or exchanger equipment. These tests are simple, uniform, and not time-consuming. Nearly all the factors involved may be controlled as desired and results obtained from varying the factors can be determined. However, the gap between even these tests and the field conditions cannot be bridged without detailed investigation of the individual problem.

Another simple method of testing is the recirculation of water at controlled velocity and temperature through apparatus composed of actual pipe nipples. This more nearly duplicates actual operation. Neither method, however, takes into account the factor of heat transfer and skin temperatures.

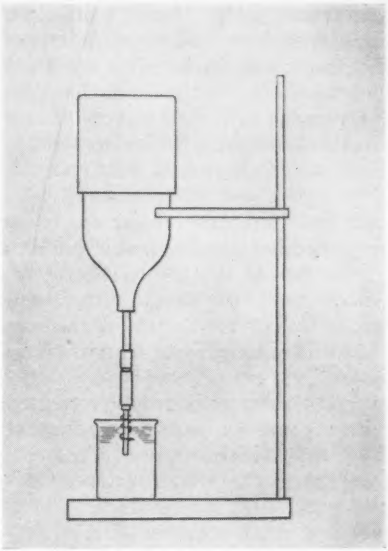

Figure 1—Testing apparatus.

In all laboratory work, it is necessary that tests and results be reproducible. Uniformity of results obtained are very good on both types of equipment mentioned.

Operating equipment experiences general corrosion, pitting, tuberculation, and mixtures of these. The same was obtained on rotating rods, and radically different types of corrosion can be obtained under varying conditions.

Sodium sulfate and sodium chloride are two of the main factors involved in considering the effect of dissolved solids on corrosion. Their contribution to corrosion has been found to be about equal and additive. Apparently with high dissolved solids, protective films that may be formed are much more easily penetrated, and consequently a higher

dosage of inhibitor is required for protection under these conditions.

Temperature also plays an important part in corrosion. Many waters can be both corrosive and scale-forming. Usually as the temperature rises, corrosion increases to a peak, after which there may be some calcium carbonate protection.

Water can carry either corrosive or protective substances or both to the surface of the metal. Therefore, with a fast flow rate, more corrosive materials are carried to the surface and the rate of corrosion is faster. Just the reverse is true, however, if the water is properly treated with a corrosion inhibitor, as a fast flow rate carries more protective material to the metal surface. Usually very little can be done to control flow rates in an established system. Flow rate should be definitely considered in the installation of test pipe nipples.

Acid type pollution that fouls surface waters usually requires proper pH control to bring the water back to a range that can be handled by normal means. The chief disadvantage that arises is that the dissolved solids may be increased to contribute to corrosion and the amount of pollution may vary so that it is difficult to control treatment.

Dissolved Gases

Dissolved gases play an important part in the problem. The presence of corrosive gases in high amounts will naturally increase the amount of corrective treatment necesary. It is usually more economical to add treatment or inhibitors to get film protection than it is to try to remove the oxygen by deaeration. In most problems involving cooling towers we are usually dealing with an oxygen content approaching the saturation point.

The effect of micro-organisms on corrosion cannot be overlooked. This slime coating prevents corrosion inhibitors from coming in contact with the metal to afford protection. Corrosive bacteria also thrive under these coatings. The organisms also tend to absorb or use up some inhibitors. Waters must be properly sterilized to eliminate any possibility of slime formations. One school of thought has felt that high dosages of chlorine might be a contributing factor to the corrosive intensity of water both from the standpoint of the gas, and the chloride ion. A number of plants are now using various phenol derivatives in non-potable systems supplementing low dosages of chlorine so as to eliminate this possibility.

Saturation Index

The pH of saturation for calcium carbonate, in relation to the actual pH, is called the "Saturation Index," and tells whether a water tends to deposit or dissolve calcium carbonate. It has been used as an indication as to whether a water is scale-forming or corrosive. However, the use of this formula for the prevention of corrosion is not always adequate because of the previously mentioned factors that contribute to corrosion and which are not included. Ryznar's "Stability Index" or ($2pH_s - pH$) gives a more accurate picture but does not necessarily give the degree of corrosion to be expected. The Stability Index, together with all the other factors mentioned, must be studied in determining the corrosive tendency of

any water. Results obtained vary according to the quantities present on either side of the balance.

Presence of a protective film on the metallic surface is the chief natural force tending to prevent corrosion. The protective surface film may be due to mineral deposited from the water, oxide from the metal surface, or some reaction product between the constituents of the water such as silica, alkalinity, organic matter, etc., and the metal. The film that forms must cover the exposed surface uniformly and completely, otherwise localized corrosion may result. A calcium carbonate scale does not necessarily protect against corrosion because it may be porous and thereby the corroding medium can penetrate to the metal.

Preventive Measures

The method selected for corrosion prevention is usually based on one or a combination of the following:

1) Material selection and equipment design to minimize the effect of corrosive environment.
2) Treatment of the water; such as deaeration and pH adjustment to make it less aggressive.
3) Protective coating by cathodic or controlled electrochemical means.
4) Protective coating by paints, plastics, etc.
5) Protective coating by film-forming chemicals applied to or present in the water and carried by the water to the metal surface.

Protective treatment dosages are determined by analysis of the water in use and of operating conditions involved, including temperatures, oxygen, and approximate flow velocity, comparing the sum of these factors to research and other field results under similar conditions.

Once-through potable water systems are primarily relying on the use of pH adjustment to change the Stability Index, and/or the use of polyphosphate types of materials. Silica is used in a limited number of systems. Much more leeway is possible in non-potable once-through systems. In addition to the above methods other inhibitors such as chromates, nitrates, sulfites, formaldehyde, and other organics are used.

Variable Factors

In recirculating systems some of the factors are in constant change in passing through the cooling tower or spray pond and this makes the problem more severe. The most common inhibitors used here are chromate types, polyphosphate types, Stability Index adjustment. Chemical deaeration is usually ineffective in open systems because of the high oxygen content. Recent developments in the recirculation field indicate that a feed of polyphosphate type of material higher than that usually used for scale prevention will give excellent corrosion inhibition. Apparently the type of thin heat permeable film established is much more uniform and lasting than other types of films such as chromates. Adjustment of pH to a figure between 6.5 and 7.5 seems to be desirable on most problems. This system has been used with excellent results, and economically, for more than 18 months in

the cooling water of one of the largest refineries in the Los Angeles Basin.

The same type of polyphosphate treatment has been used more than a year to inhibit corrosion in producing oil wells in Southern California, with very promising results. Another possible application is extensive pipeline systems.

In addition to the use of chemical deaerators, such as sulfites and nitrites for boiler feedwater work, organics have a definite place in the picture. Blends of organic material such as quebracho, chestnut, or hemlock can give oxygen scavenging as well as permanent heat permeable protective films within the boiler. However, for boiler use they must be selected and processed so that they are compatible with the treatment from standpoint of scale and wet steam prevention.

Use of Amines

The use of volatile alkaline amine materials for protection against corrosion in return condensate and hydrocarbon systems is not a new idea, but in actual practice their application has been hampered by insufficient knowledge of the best amines to use and the proper method of application. The characteristics of individual amines vary with conditions of temperature and pressure and with some amines, only certain sections of a system have received adequate protection. Since no one amine has volatilizing and condensing characteristics variable enough to meet the range of conditions encountered in a complete condensate system, liquid treatments containing a blend of several amines have been developed. Three types of blends are used, each one designed to operate under specific ranges of temperatures and pressures.

It is believed these amines will prove useful in combating corrosion in hydrocarbon systems, where ammonia might prove dangerous to copper alloys.

Protective treatment dosages on various problems are controlled by frequent testing of the water to observe changes in Stability Index, oxygen, flow rates, or other factors involved. Any chemical treatment must be followed closely by laboratory analysis and proper concentrations must be maintained.

Formulae dealing with the main factors affecting corrosion are being developed, but detailed answers for all conditions are not available. Much more laboratory research work such as outlined earlier and complete proof in actual plant operation is necessary. Even then the problem has only been solved as far as the chemical inhibition is concerned. There still remains galvanic corrosion and the wide dissimilarity of metals in some systems that require different methods of protection. Many pieces of equipment may obtain a more economical protection by the use of chemical inhibitors as well as cathodic protection.

Conclusion

The purpose has been to show that prevention of trouble is accomplished only when many factors are considered. These factors should be studied carefully before recommending the choice of polyphosphate, chromate, silicate, chromate-phenol, amine, sulfite, or organic type of inhibitors.

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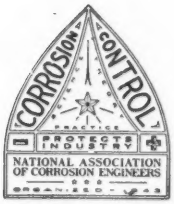

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Donoho, Charles K.
American Cast Iron Pipe Co.
Box 2603
Gamble, Charles B.
Birmingham Gas Co.
First Avenue North
Harris, R. L.
Alabama Power Co.,
600 N. 18th St.
Hunter, Charles M.
Southern Natural Gas Co.
Watts Bldg.
McCauley, E. D.
American Cast Iron Pipe Co.
Box 2603
MacKenzie, James T.
American Cast Iron Pipe Co.
Box 2603
Parker, W. A.
Southern Natural Gas Co.
Watts Bldg.
Puryear, R. A., Jr.
Alabama Gas Co.
Box 237
Ramsey, Jack W.
Southern Bell Telephone & Telegraph Co.
Phoenix Bldg.
Yeldell, J. W.
Southern Natural Gas Co.
Box 2563

MOBILE
Strange, Harold T.
Mobile Gas Service Corp.
Box 1130

WILSON DAM
Tait, Emmitte P.
Tennessee Valley Authority

ARIZONA

COOLIDGE
Bell, Lawrence H.
Natural Gas Service Co. of Arizona
Box 127

ARKANSAS

CARLISLE
Lowther, G. B.
Mississippi River Fuel Co
Box 142

EL DORADO
Bertetti, John W.
Root Petroleum Co.
Hardcastle, C. A.
Lion Oil Refining Co.
Exchange Bldg.
Rogerson, J. B.
Lion Oil Refining Co.
Exchange Building

FORT SMITH
Ullrich, A. H.
City of Fort Smith Water Dept.
City Hall

JONESBORO
Green, W. A.
Arkansas Power & Light Co.

LITTLE ROCK
Callahan, V. L.
Southern Acid & Sulphur Co., Inc.
Box 991
Mayhan, W. A.
Little Rock Municipal Waterworks
Municipal Auditorium

CALIFORNIA

ALHAMBRA
Smith, Martin B.
American Pipe & Steel Corp.
2201 W. Commonwealth

AVENAL
Knowlton, D. R.
Kettleman North Dome Assoc.
Bin C

AZUSA
Stromsoe, Douglas A.
Southern Pipe & Casing Co.
Box C

BAKERSFIELD
Smith, Clair J.
Western Gulf Oil Co.
Box 471

BELL
Schilling, W. M.
Southern Counties Gas Co.
4818 Beck Ave.

BERKELEY
Chadwick, H. M.
Armco Drainage & Metal Products, Inc.
Seventh & Parker Sts.
Jurs, Peter C.
Shand & Jurs Co.
917 Carlton St.

BEVERLY HILLS
O'Leary, F. J.
Barrett Div., Allied Chemical & Dye Corp.
308 S. Clark Drive

EL SEGUNDO
Behn, Daniel R.
California Research Corp.
324 El Segundo Blvd.

EMERYVILLE
Brady, Merritt H.
Pacific Gas & Electric Co.
4245 Hollis St.
Breitenbach, Paul
Pacific Gas & Electric Co.
4245 Hollis St.
Dean, Roy O.
Pacific Gas & Electric Co.
4245 Hollis St.
Eldredge, G. G.
Shell Development Co.
4560 Horton St.
Finley, Dozier
The Paraffine Co., Inc.
1550 Powell St.
Fox, Arthur R.
Shell Development Co.
4560 Horton St.
Schneider, W. R.
Pacific Gas & Electric Co.
4245 Hollis St.
Treseder, R. S.
Shell Development Co.
4560 Horton St.
Wachter, Aaron
Shell Development Co.
4560 Horton St.
Weber, Martin K.
Shell Development Co.
4560 Horton St.

FONTANA
Madden, R. C.
Kaiser Co., Inc.
Box 217

HERMOSA BEACH
Phillians, T. F.
40-21st St.

LA MESA
Shelton, M. J.
La Mesa, Lemon Grove & Spring Valley Irrigation District
4769 Spring St.

LINCOLN
Johnson, E. A.
Consulting Engineer
Box 501

LONG BEACH
Higgins, Frank T.
City of Long Beach Water Dept.
215 W. Broadway
Wells, C. Kenyon
Long Beach Water Dept.
215 W. Broadway

LOS ANGELES
Alexander, L. J.
Southern California Water Co.
1206 S. Maple Ave.
Ashline, Robert R.
Dept. of Water & Power, City of Los Angeles
207 S. Broadway
Atkin, Howard P.
The Dow Chemical Co.
634 S. Spring St.
Barcus, E. Dale
Pacific Telephone & Telegraph Co.
740 S. Olive St.
Bechtold, Ira C.
The Fluor Corp., Ltd.,
2500 S. Atlantic Blvd.
Blohm, Clyde L.
The Fluor Corp., Ltd.,
2500 S. Atlantic Blvd.
Bradfield, S. A.
Southern California Gas Co.
810 S. Flower St.
Bradley, F. E.
Chanslor-Canfield Midway Oil Co.
4561 Produce Plaza W.
Buratti, Carl
Johns-Manville Sales Corp.
816 W. Fifth
Caldwell, Isaac P.
Allied Supply Co.
2068 E. 37th
Cates, Walter H.
Western Pipe & Steel Co. of California
5717 Santa Fe Ave.
Corfield, Guy
Southern California Gas Co.
Box 3249, Terminal Annex
Dietze, Irwin C.
Dept. of Water & Power, City of Los Angeles
141 S. Martel Ave.

Dod, A. Bayard, Jr.
Phelps Dodge Copper Products Corp.
6100 Garfield Ave.
Dorsey, Joseph S.
Southern California Gas Co.
Box 3249, Terminal Annex
Elliott, Jack H.
Ralph M. Westcott Co.
1700 S. Main St.
Gilbert, T. H.
Southern California Gas Co.
Box 3249, Terminal Annex
Goit, Laurance E.
Dept. of Water & Power, City of Los Angeles
Box 3669, Terminal Annex
Graham, Donald W.
Dept. of Water & Power, City of Los Angeles
207 S. Broadway
Gregory, Charles N.
Southern Counties Gas Co. of California
3718½ S. Hope St.
Hall, E. B.
E. B. Hall & Co.
523 W. Sixth St.
Harris, Jack H. L.
Wright Chemical Corp.
122 E. Seventh St.
Hiskey, D. R.
Dearborn Chemical Co.
807 Mateo St.
Hough, Fred A.
Southern Counties Gas Co. of California
810 S. Flower St.
Kartinen, Ernest O.
Signal Oil & Gas Co.
811 W. Seventh St.
Keeling, Harry J.
Southern Counties Gas Co. of California
810 S. Flower St.
Munger, C. G.
Amercoat Division, American Pipe & Construction Co.
Box 3428, Terminal Annex
Perier, Claude H.
Dept. of Water & Power, City of Los Angeles
405 S. Hill St.
Phillian, T. F.
Shell Oil Co. Inc.
1008 W. Sixth St.
Price, H. A.
Dept. of Water & Power, City of Los Angeles
207 S. Broadway
Purdy, D. F.
Richfield Oil Corp.
Richfield Bldg.
Savage, Robert H.
Ralph M. Westcott Co.
1700 S. Main St.
Sawyer, Mark A.
Pacific Telephone & Telegraph Co.
740 S. Olive St.
Schmidt, R. W.
Southern Counties Gas Co. of California
2132 Atlantic St.
Scott, Gordon N.
Industrial Engineering Co.
555 S. Flower St.
Senatoroff, N. K.
Southern Counties Gas Co. of California
810 S. Flower St.
Smith, Turner C.
General Petroleum Corp.
2525 E. 37th St.
Stauffacher, E. R.
Southern California Edison Co., Ltd.
Box 351
Stephens, Foster M.
The Fluor Corp., Ltd.
2500 S. Atlantic Blvd.
Stevenson, R. A.
641 Gibbons St.
Sullivan, Ray L.
Calgon, Inc.
1807 E. Olympic Blvd.
Supple, George H.
General Petroleum Corp.
108 W. Second St.
Vail, Harold P.
Metropolitan Water Dist. of Southern California
306 W. Third St.
Waters, F. O.
Southern California Gas Co.
Box 3249, Terminal Annex
Young, Garth L.
Signal Oil & Gas Co.
811 W. Seventh St.

MARTINEZ
Effinger, R. T.
Shell Oil Co., Inc.

MORRO BAY
Lawrence, W. H.
Valley Pipe Line Co.
Box 217

NATIONAL CITY
Magoffin, Linne
California Water & Telephone Co.
19 W. Ninth St.

NORTH HOLLYWOOD
Jones, David T.
Southern California Telephone Co.
4364 Farmdale Ave.

OAKLAND
Knopp, Harold P.
Electrical Facilities, Inc.
4224 Holden St.

PASADENA
Blackburn, Duncan A.
City of Pasadena Water Dept.
100 N. Garfield Ave.
Gally, Sidney K.
Southern California Gas Co.
219 S. Wilson Ave.
Ott, Lawrence H.
Rheem Manufacturing Co.
170 E. California St.
Pomeroy, Richard
Montgomery & Pomeroy
40 W. Green St.
Simmons, Edward E., Jr.
Rheem Manufacturing Co.
170 E. California St.

RICHMOND
Putnam, Joseph F.
California Research Corp.
Box 1627

ROSEMEAD
Kershner, Daniel C.
Alox Corp.
1929 E. Rose St.

SAN DIEGO
Goldkamp, Chris A.
San Diego Gas & Electric Co.
Electric Bldg.
Klauber, L. M.
San Diego Gas & Electric Co.
Box 1831
Rogness, E. C.
San Diego Gas & Electric Co.
Civic Center Bldg.

SAN FRANCISCO
Beutel, P. R.
The Dow Chemical Co.
310 Sansome St.
Evans, J. M.
Standard Oil Co. of California
225 Bush St.
Farwell, Milo S.
Bethlehem Pacific Coast Steel Co.
20th & Illinois Sts.
Howell, R. P.
Standard Oil Co. of California
225 Bush St.
Payne, Harrison S.
The Pacific Telephone & Telegraph Co.
140 New Montgomery St.
Pell, Duncan C., III
Glaspray Process Co., Inc.
520 Bay St.
Sparks, Lt. Comdr. Robert E.
Base Maintenance Section
Staff Comservpac
Box 34, Fleet Post Office

SOUTH GATE
Munger, Charles G.
American Pipe & Construction Co.
4635 Firestone Blvd.

TRACY
Davie, Frank E.
Shell Oil Co., Inc.
Box 329

WILMINGTON
Artese, S. J.
Shell Oil Co., Inc.
Box 728
Dunham, R. A.
Union Oil Co. of California
Hall, R. E.
Union Oil Co. of California
Jenkins, Vance N.
Union Oil Co. of California
Michaud, M. L.
Union Oil Co. of California

COLORADO

BOULDER
Rohrman, F. A.
Engineering Experimental Station
University of Colorado

COLORADO SPRINGS
Abbott, C. B.
Colorado Interstate Gas Co.
Box 1087
Hagius, Karl S.
Colorado Interstate Gas Co.
Box 1087
McClintock, Robert D.
Colorado Interstate Gas Co.
Box 1087

DENVER
Burnett, Graydon E.
Bureau of Reclamation
Denver Federal Center
Fry, Frank B.
Public Service Co. of Colorado
15th & Champa Sts.
Garrett, G. H.
Thompson Pipe & Steel Co.
Box 2369
Gilliland, John L., Jr.
Bureau of Reclamation
Custom House

Miller, Donald J.
Public Service Co. of Colorado
900 15th St.
Sharp, Hubert
Mountain States Telephone & Telegraph Co.
931 14th St.
Wheatlake, B. K.
Dearborn Chemical Co.
Equitable Bldg.
RIFLE
Barkow, C. W.
U. S. Bureau of Mines
Oil-Shale Demonstration Plant

CONNECTICUT

HARTFORD
Hamilton, Archer B.
The Hartford Gas Co.
233 Pearl St.
NEW HAVEN
Meyer, Frederick R.
Southern New England Telephone & Telegraph Co.
227 Church St.
Nixon, James A.
Southern New England Telephone & Telegraph Co.
227 Church St.
WATERBURY
Barry, Frederic M.
Scovill Manufacturing Co.
99 Mill St.
Mitchell, N. W.
Chase Brass & Copper Co.
236 Grand St.
Nole, Vito F.
Chase Brass & Copper Co.
236 Grand St.
Presley, Maurice C.
Scovill Manufacturing Co.
99 Mill St.
Price, David W.
The Connecticut Light & Power Co.
250 Freight St.
Tracy, Arthur W.
The American Brass Co.
WESTPORT
Wells, David F.
The Dorr Co., Inc.
Westport Mill

DELAWARE

NEW CASTLE
Parnell, John B.
Gates Engineering Co.
New Castle Ave.
WILMINGTON
Brown, Marshall H.
E. I. du Pont de Nemours & Co., Inc.
10th & Market Sts.
Crane, B. G.
E. I. du Pont de Nemours & Co., Inc.
10th & Market Sts.
Myers, Ward R.
E. I. du Pont de Nemours & Co., Inc.
10th & Market Sts.

DISTRICT OF COLUMBIA

WASHINGTON
Boothby, Everett J.
Washington Gas Light Co.
11th & H Sts., N. W.
Childs, Benjamin F.
Washington Gas Light Co.
11th & H Sts., N. W.
De Masi, Robert R.
The Chesapeake & Potomac Telephone Co.
725 13th St., N. W.
Denison, I. A.
National Bureau of Standards
Underground Corrosion Section
Donnelly, Robert M.
Strategic Air Command Hdq.
Andrews Field
Farrar, Walter B.
Office of Chief of Engineers
21st & Virginia Sts.
Florreich, E. L.
U. S. Dept. of Agriculture
Rural Electrification Adm.
Agricultural Bldg.
Glass, Frank H.
Centro Research Laboratories, Inc.,
483 Orange St., S. E.
Greathouse, Glenn A.
National Research Council
2101 Constitution Ave.
Holler, Homer D.
National Bureau of Standards
East Bldg., Rm 207
Leas, A. Robert
Williams Bros. Corp.
1026 17th St., N.W.
Logan, Kirk H.
National Bureau of Standards
Cast Iron Pipe Research Assoc.
May, Thomas P.
N. S. Naval Research Laboratory
Shepard, E. R.
Office of Chief of Engineers
War Department
2425 Connecticut Ave.
Sime, Robert M.
Chesapeake & Potomac Telephone Co.
1111 N. Capitol St.
Sward, G. G.
National Paint, Varnish & Lacquer Assoc., Inc.
1500 Rhode Island Ave., N. W.
Waldron, Leo J.
Federal Public Housing Authority
1201 Connecticut Ave.
Wight, Kent M.
Underground Corrosion Section
National Bureau of Standards

FLORIDA

DAYTONA BEACH
Quelch, Geo. C., Jr.
North Florida Test Service
531 Revilo Blvd.
GAINESVILLE
Kimmel, Albert L.
University of Florida
Box 2368, University Station
MIAMI
Broom, Charles M.
Florida Power & Light Co.
Box 3100
DeNoon, E. M.
South Florida Test Service
Box 387
Frink, Joe
Florida Power & Light Co.
Box 3100
Summers, C. H.
Florida Power & Light Co.
Box 3100

GEORGIA

ATLANTA
Boyd, P. B.
Georgia Power Co.
Box 1719
Britton, H. B.
Plantation Pipe Line Co.
Box 1743
Burdsal, Arthur J.
Southern Bell Telephone & Telegraph Co.
Cauthen, H. W.
Georgia Power Co.
127 Butler St., S.E.
Hereford, Arthur J.
International Engineering Corp.
Glenn Bldg.
Horstman, W. G.
Plantation Pipe Line Co.
P. O. Box 1743
Johnston, J. Flynn
American Telephone & Telegraph Co.
Hurt Bldg.
Nelson, Alan C.
Plantation Pipe Line Co.
Box 1743
Swanson, A. R.
American Telephone & Telegraph Co.
Hurt Bldg.
West, John B.
Aluminum Co. of America
Rhodes-Haverty Bldg.
Winters, B. W.
Southeastern Pipe Line Co.
Forsyth Bldg.
BREMEN
Parker, Ivy M.
Plantation Pipe Line Co.
Box 266

IDAHO

BOISE
Waterman, Howard E.
Idaho Power Co.
1220 Idaho St.

ILLINOIS

ARGO
Fluornoy, R. W.
Corn Products Refining Co.
BELLWOOD
Bennan, James M.
Jefferson Electric Co.
25th Ave. & Madison
BROOKFIELD
Hart, M. B.
Illinois Bell Telephone Co.
4411 Du Bois
CHICAGO
Abbey, Oscar A.
Standard Oil Co. of Indiana
910 S. Michigan Ave.
Alk, Lewis C.
James B. Clow & Sons
Box 6600A
Anderson, Chester
The Crane Co.
836 S. Michigan Ave.
Bartlett, Harold J.
The Crane Co.
836 S. Michigan Ave.

Biddison, P. McDonald
135 La Salle St.
Bjorksten, Johan
Bee Chemical Co.
63 E. Lake St.
Boberg, Irving E.
Chicago Bridge & Iron Co.
1305 W. 105th St.
Bradbury, J. E.
The Crane Co.
836 S. Michigan Ave
Brightly, Frederick C., Jr.
Standard Galvanizing Co.
2619 W. Van Buren St.
Buell, James H.
Middle West Service Co.
20 N. Wacker Drive
Burlingame, M. V.
Natural Gas Pipeline Co. of America
20 N. Wacker Drive
Casey, J. Pat, Jr.
The Crane Co.
836 S. Michigan Ave.
Clancy, J. J.
Koppers Co., Inc., Wailes Dove-Hermiston Dept.
105 W. Adams St.
Converse, E. M.
Dearborn Chemical Co.
310 S. Michigan Ave.
Croft, William F.
Standard Oil Co. of Indiana
910 S. Michigan Ave.
Erickson, E. T.
Dearborn Chemical Co.
310 S. Michigan Ave.
Farkas, M. B.
The Sherwin-Williams Co.
115th & Cottage Grove Ave.
Fisher, H. E.
Standard Oil Co. of Indiana
910 S. Michigan Ave.
Fletcher, Mark D.
Illinois Bell Telephone Co.
215 W. Randolph St.
Foelsch, Henry W.
Lithgow Corp.
333 W. 40th Place
Glass, D. C.
Pure Transportation Co.
35 E. Wacker Drive
Greve, Lyman F.
Commonwealth Edison Co.
72 W. Adams St.
Haering, Vera W.
D. W. Haering & Co., Inc.
205 Wacker Drive
Hutchinson, Carroll O.
Nubian Industrial Div., The Glidden Co.
1856 N Le Claire Ave.
Jablonski, E. F.
Hunter Laboratories
1938 S. Christiana Ave.
Kaszynski, John F.
Witco Chemical Co.
6200 W. 51st St.
Kolzow, Clarence R.
Western Electric Co.
5555 Archer Ave.
Ledford, Raymond F.
Hanson-Van Winkle-Munning Co.
2920 Carroll Ave.
Lieber, Eugene
Nox-Rust Chemical Corp.
2429 S. Halsted St.
Loudenback, Clyde I.
Dearborn Chemical Co.
310 S. Michigan Ave.
Lynch, Raymond P.
Chicago District Pipeline Co.
122 S. Michigan Ave.
Macdonald, Frank P.
Electro Rust-Proofing Corp.
407 S. Dearborn St.
McClenahan, W. T.
Sanitary District of Chicago
910 S. Michigan Ave.
McDonald, Hugh J.
Illinois Institute of Technology
3300 Federal St.
Mensch, Ralph G.
Industrial Coatings Corp.
3227 S. Shields Ave.
Modieska, R. Scott
Scientific Control Laboratories
600 Blue Island Ave.
Morse, Arley E.
The Dow Chemical Co.
135 S. La Salle St.
Mosman, Chester R.
American Telephone & Telegraph Co.
311 W. Washington St.
Nelson, Roland E.
H. K. Porter & Co., Inc.
332 S. Michigan Ave.
Payton, Victor J.
Commonwealth Edison Co.
72 W. Adams St.
Perry, Russell I.
Commonwealth Edison Co.
72 W. Adams St.
Pettyjohn, E. S.
Institute of Gas Technology
3300 Federal St.
Pietrowicz, A. L.
Chicago Plating Co.
1714 W. Division St.
Ranta, Leo G.
The Peoples Gas, Light & Coke Co.
122 S. Michigan Ave.
Rio, Anthony J.
Illinois Bell Telephone Co.
315 W. Washington St.
Roberts, R. G.
Barrett Division, Allied Chemical & Dye Corp.
1400 Lake Shore Drive
Routson, L. B.
Western Union Telegraph Co.
427 S. La Salle St.
Schmitz, Carl Edward
Crane Packing Co.
1800 Cuyler Ave.
Seidel, G. E.
Amercoat Division, American Pipe & Construction Co.
4554 N. Broadway
Seif, M. A.
Sharples Chemicals, Inc.
80 E. Jackson St.
Serbula, Steve Jr.
Rust-Oleum Corp.
228 N. La Salle St.
Seyl, Robert G.
Continental Can Co., Inc.
4645 W. Grand Ave.
Shelves, Arthur R.
Koppers Co., Wailes Dove-Hermiston Dept.
105 W. Adams St.
Sheridan, S. A.
Armour Research Foundation
35 W. 33rd St.
Shoan, Raymond A.
Dearborn Chemical Co.
1029 W. 35th St.
Smith, Carl B.
Dearborn Chemical Co.
310 S. Michigan Ave.
Sommers, Warren A.
Illinois Institute of Technology
3300 S. Federal St.
Stefanides, Victor N.
Illinois Tool Works
2501 Keeler Ave.
Stobie, John J., Jr.
Apex Smelting Co.
2537 W. Taylor St.
Strothman, E. P.
A. O. Smith Corp.
310 S. Michigan Ave.
Svrchek, Joseph G.
Dearborn Chemical Co.
310 S. Michigan Ave.
Thompson, Harris
National Aluminate Corp.
6216 W. 66th Place
Trissal, J. M.
Illinois Central Railroad Co.
135 E. 11th Place
Underwood, O. G.
United Chromium, Inc.
6751 Oglesby Ave.
Vande Bogart, L. G.
The Crane Co.
836 S. Michigan Ave.
Van Loo, Maurice
The Sherwin-Williams Co.
115th St. & Cottage Grove Ave.
Waber, James T.
Illinois Institute of Technology
3300 S. Federal St.
Wilkes, John F.
Dearborn Chemical Co.
310 S. Michigan Ave.
Wright, Calvin C.
Ludwig Wilson Co.
112 S. Franklin St.
Ziemann, C. L.
Lithgow Corp
333 W. 40th Place

DECATUR
Bowman, Walter J.
Mueller Co.

EAST ST. LOUIS
Heideman, William A.
Socony-Vacuum Oil Co., Inc.
South 20th St.

EVANSTON
Baird, Hugh W.
Barrett Division, Allied Chemical & Dye Corp.
2607 Colfax St.
Bohne, A. W.
The Tapecoat Co.
1521-23 Lyons St.
Fergusson, Robert A.
Rust-Oleum Corp.
2425 Oakton St.
McGee, Herbert S.
Public Service Co. of Northern Illinois
2522 Noyes St.
Sanford, Frank E.
McGraw-Hill Pub. Co.
2620 Central Park Ave.

FRANKLIN PARK
Imes, A. D.
Pipe Line Service Corp.
Box 218
GLENCOE
Davis, Leroy J.
Public Service Co.
of Northern Illinois
Box 278
GRAYVILLE
Reese, Max
JOLIET
Boone, Harold C.
The Texas Pipe Line Co.
1017 Richmond
Humphrey, Merle G.
American Telephone &
Telegraph Co.
7 E. Clinton St.
KANKAKEE
Higgins, Waldo W.
A. O. Smith Corp.
655 S. Harrison Ave.
LOCKPORT
Nealy, V. L.
The Texas Co.
831 State St.
MACOMB
Kettron, Henry P.
Illinois Electric Porcelain
Co.
510 Pearl St.
MAYWOOD
Weaver, H. E.
Public Service Co.
of Northern Illinois
1319 S. First Ave.
MORTON GROVE
Hinde, J. Nelson
Bell & Gossett Co.
NORRIS CITY
Williams, Harry M.
Texas Eastern
Transmission Corp.
Box 1
NORTHFIELD
Jackson, Maynard H.
Hill, Hubbell & Co.,
Divisions, General Paint
Corp.
251 Wagner Road
OAK PARK
Jensen, O. L.
Public Service Co.
of Northern Illinois
1001 S. Taylor Ave.
Nichols, Laurie E.
Public Service Co.
of Northern Illinois
1001 S. Taylor Ave.
PEORIA
Blaine, Russel K.
Hiram Walker & Sons, Inc.
Foot of Edmund St.
PERU
Smith, William N.
Wood River Oil & Refining
Co.
335 W. Lewis
ROBINSON
Lyon, C. W.
The Ohio Oil Co.
SKOKIE
McLeod, Raymond H.
Electro Rust-Proofing
Corp.
7439 N. Kenneth Ave.
URBANA
Larson, Thurston E.
Illinois State Water
Survey Division
60 Noyes Laboratory
Wainwright, Ray M.
University of Illinois
Dept. of Electrical
Engineering
WOOD RIVER
Plovanich, Paul P.
Shell Oil Co., Inc.
Box 262

INDIANA

EAST CHICAGO
Pulver, Robert E.
Socony-Vacuum Oil Co.,
Inc.
Rush, E. H.
Shell Oil Co., Inc.
200 Carroll St.
EVANSVILLE
Berry, Norton E.
Servel, Inc.
119 N. Morton Ave.
HAMMOND
Leeds, Donnelly A.
Northern Indiana Public
Service Co.
5265 Hohman Ave.
INDIANAPOLIS
Cantwell, Guy H.
Indiana Bell Telephone Co.
240 Meridian St.
Higburg, Wm.
Reilly Tar & Chemical
Corp.
Merchants Bank Bldg.
Honecker, Walter C.
Indiana Bell Telephone Co.
240 N. Meridian St.
Lane, Russell W.
National Aluminate Corp.
3615 N. Colorado Ave.
Martin, D. S.
Citizens Gas & Coke
Utility
330 W. Ninth St.
Payne, Paul B.
Dearborn Chemical Co.
Chamber of Commerce
Bldg.
Seal, Wm. D.
Indianapolis Power &
Light Co.
17 N. Meridian St.
KOKOMO
Chisholm, Charles G.
Haynes Stellite Co.
725 S. Lindsay
LAFAYETTE
Bonnet, Robert W.
Duncan Electric Mfg. Co.
244 S. Third St.
Coleman, O. K.
Consulting Engineer
Box 705
LA PORTE
Stockhausen, Frank H.
Bastian-Morley Co., Inc.
200 Truesdell St.
TERRE HAUTE
Bachman, Paul W.
Commercial Solvents Corp.
ZIONSVILLE
Berringer, John C.
Panhandle Eastern Pipe
Line Co.
Box 231
Johnson, J. F., Jr
Shell Oil Co., Inc.
Drawer A

IOWA

COUNCIL BLUFFS
Gilbert, A. A.
National Co-Operative
Refinery Assoc.
Box 539
DAVENPORT
Williams, Geo. T.
The United Light & Rail-
ways Service Co.
United Light Bldg.
DES MOINES
Beattie, George
Iowa Power & Light Co.
312 Sixth Ave.
De Hann, Peter C.
Iowa Power & Light Co.
312 Sixth Ave.
Leland, C. A.
Iowa Power & Light Co.
312 Sixth Ave.
SIOUX CITY
Dougherty, Wm. J.
Sioux City Gas & Electric
Co.
515 Fifth St.

KANSAS

ABILENE
Murray, W. J.
Central Gas Utilities Co.
304 N. Cedar
AUGUSTA
Bedell, H. L.
Socony-Vacuum Oil Co.,
Inc.
White Eagle Division
BURRTON
Pettijohn, Dale S.
Panhandle Eastern Pipe
Line Co.
R. R. L.
HUTCHINSON
Sheline, H. F.
The Drillers Gas Co.
24 W. Fifth St.
INDEPENDENCE
Baker, W. W.
Sinclair Refining Co.
Box 460
Fell, Paul D.
Sinclair Refining Co.
Box 460
LIBERAL
Graver, W. E.
Panhandle Eastern Pipe
Line Co.
Box 979
McPHERSON
Mary, E. J.
National Cooperative
Refinery Assoc.
Box 707
Roberts, Louis E.
National Cooperative
Refinery Assoc.
Box 770
PAOLA
Fowler, James A., Jr.
Panhandle Eastern Pipe
Line Co.
PITTSBURG
MacArthur, J. G.
Spencer Chemical Co.
Box 604
Miller, Ralph D.
Spencer Chemical Co.
Box 604
Woodward, Henry F. Jr.
Spencer Chemical Co.
Box 604
RUSSELL
Oakes, Tyrus G.
Texas Pipe Line Co.
97 S. Maple St.
WICHITA
Begole, Edgar Ray
Socony-Vacuum Oil Co.,
Inc., White Eagle Divi-
sion
First National Bank Bldg.

Blazer, H. L.
Cooperative Pipe Line Assoc.
402 Schweiter Bldg.
Corey, Bruce L.
Socony-Vacuum Oil Co., Inc., White Eagle Division
Box 1882
Dickinson, L. R.
Socony-Vacuum Oil Co., Inc., White Eagle Division
First National Bank Bldg.
Johansen, Irving H.
Socony-Vacuum Oil Co., Inc., White Eagle Division
Box 1882
Phipps, Harry K.
Socony-Vacuum Oil Co., Inc., White Eagle Division
First National Bank Bldg.
Rupf, J. Albert
Socony-Vacuum Oil Co., Inc., White Eagle Division
First National Bank Bldg.
Schnepel, Palmer W.
Paldon Contracting Co., Inc.
2311 Rivera St.
Stephens, E. H.
Westinghouse Electric Corp.
301 S. Market St.
Sutter, Carl H.
Kansas Gas & Electric Co.
201 N. Market St.

KENTUCKY

LEXINGTON
Coffinberry, Arthur S.
University of Kentucky
LOUISVILLE
Ayers, Martin R.
Martin R. Ayers Co.
1000 E. Kentucky St.
Benson, Lamont J.
Reynolds Metals Co.
2000 S. Ninth St.
Miller, Frank H., Jr.
Enterprise Chemical Corp.
213 W. Main St.
Schneider, R. W.
Nokem Engineering Co., Inc.
216 W. Washington St.

LOUISIANA

BATON ROUGE
Draughon, Charles R., Jr.
Standard Oil Co. of New Jersey (Louisiana Division)
Box 551
O'Brien, Paul S.
Socony Paints Products Co.
630 Laurel St.
Tuthill, Arthur H.
Standard Oil Co. of New Jersey, (Louisiana Division)
Box 551
COTTON VALLEY
McGuire, T. W.
Cotton Valley Operators' Committee
Box 1008
GRETNA
Cabrera, William H.
Louisiana Power & Light Co.
711 Second St.
HARVEY
Roderick, Richard
Humble Oil & Refining Co.
Box 175
LAKE CHARLES
Hargroder, A. D.
Mathieson Alkali Works
Schofer, Nathan
Cities Service Refining Corp.
MONROE
Givens, Allen T.
Southern Gas Lines, Inc.
Drawer 1562
Stevens, Ward W.
Commercial Solvents Corp.
Box 1471
NEW ORLEANS
Besse, C. P.
The California Co.
Canal Bldg.
Durning, A. W.
Louisiana Power & Light Co.
142 Delaronde St.
Gaidry, H. L.
New Orleans Public Service Inc.
317 Baronne St.
Hess, W. T.
Louisiana Power & Light Co.
142 Delaronde St.
Ireland, L. G.
New Orleans Public Service Inc.
317 Baronne St.
Kipp, E. M.
The California Co.
1818 Canal Bldg.
Kuhn, Robert J.
2724 Octavia St.
Lewis, Charles E.
Louisiana Power & Light Co.
142 Delaronde St.
McKain, G. D.
The California Co.
Canal Bldg.
McLaren, James
U. S. Dept. of Agriculture
2100 Robert E. Lee Blvd.
Sevin, Lloyd L.
Louisiana Power & Light Co.
142 Delaronde St.
Stewart, C. A.
United Gas Pipe Line Co.
Box 1628
Trouard, Sidney E.
New Orleans Public Service Inc.
317 Baronne St.
Wadick, J. K.
Ross-Wadick Supply Co. Distributors Briggs Bituminous Composition Co.
333 Lafayette St.
Watson, M. P.
United Gas Pipe Line Co.
Box 1628
PORT SULPHUR
Monroe, J. E., Jr.
Freeport Sulphur Co.
Box 657
Oliver, Rufus W., Jr.
Freeport Sulphur Co.
Box 657
SHREVEPORT
Abernathy, M. A.
United Gas Pipe Line Co.
Box 1407
Atkins, Emery L.
United Gas Pipe Line Co.
Box 1407
Arthur, H. M.
Atlas Oil Refining Corp.
Box 1607
Babcock, L. F.
Arkansas Fuel Oil Co.
Slattery Bldg.
Barrow, D. M.
Arkansas Fuel Oil Co.
Slattery Bldg.
Beezley, H. V.
United Gas Pipe Line Co.
Box 1407
Bennett, H. R.
Union Producing Co.
Box 1407
Bradford, Warren S.
Arkansas Louisiana Gas Co.
Slattery Bldg.
Broome, W. A.
Arkansas Louisiana Gas Co.
Slattery Bldg.
Chandler, P. J.
Arkansas Louisiana Gas Co.
Slattery Bldg.
Cornett, W. J.
United Gas Pipe Line Co.
Box 1407
Evans, C. W.
United Gas Pipe Line Co.
Box 1407
Greco, Edward C.
United Gas Pipe Line Co.
Box 1407
Griffin, H. T.
United Gas Pipe Line Co.
1515 Fairfield Ave.
Griggs, Henry P.
Texas Eastern Transmission Co.
Box 1612
Holcombe, Tom L.
Dearborn Chemical Co.
Ardis Bldg.
Jordan, Raymond C.
United Gas Pipe Line Co.
Box 1407
Kendrick, J. L.
United Gas Pipe Line Co.
Box 1407
Koenig, E. A.
Texas Eastern Transmission Corp.
Box 1612
Levert, W. F.
United Gas Pipe Line Co.
Box 1407
McDonald, T. B.
United Gas Pipe Line Co.
Box 1407
McGuffy, E. L.
Crane Packing Co.
194 Ardmore St.
Olson, G. R.
United Gas Pipe Line Co.
Box 1407
Pullen, P. T.
Electro Rust-Proofing Corp.
2624 Lake Shore Drive

Ringer, Francis W.
Interstate Oil Pipe Line Co.
Box 1107
Schlather, Max F.
United Gas Pipe Line Co.
Box 1407
Spinks, Lee N.
United Gas Pipe Line Co.
Box 1407
Stearns, D. E.
D. E. Stearns Co.
Box 1234
Sullivan, E. H.
United Gas Pipe Line Co.
Box 1407
Teddlie, B. F.
Atlas Oil & Refining Corp.
Box 1607
Thibodaux, Paul T., Jr.
Wood Engineering & Construction Co.
Ardis Bldg.
Wheeler, A. W.
Graybar Electric Co.
3621 Greenway Pl.
Wilkes, Frank M.
Southwestern Gas & Electric Co.

SULPHUR
Clarke, F. Tackett
The Union Sulphur Co., Inc.
Griffin, James P.
The Union Sulphur Co., Inc.

WEST MONROE
Vaughan, Charles E., Jr.
Louisiana Power & Light Co.
101 Cotton St.

WINNFIELD
Thornton, Jesse M.
The Carey Salt Co.
Box 471

MAINE

ORONO
Axtell, Oliver
10 Mill St.

PORTLAND
Batchelder, C. Donald
Portland Pipe Line Corp.
335 Forest Ave.

MARYLAND

ANNAPOLIS
Basil, John Leslie
U. S. Naval Experiment Station

BALTIMORE
Allen, J. E.
Pennsylvania Water & Power Co.
Lexington Bldg.
Darrin, Marc
Mutual Chemical Co. of America
1348 Block St.
Dwyer, T. J.
Consolidated Gas Electric Light & Power Co. of Baltimore
Front St. Bldg.
Huston, Kenneth M.
Rustless Iron & Steel Co.
3400 E. Chase St.
McCormick, Lawrence O.
Consolidated Gas Electric Light & Power Co. of Baltimore
Madison & Constitution Sts.
Powell, Sheppard T.
Consulting Engineer
330 N. Charles St.
Wolf, Edgar F.
Consolidated Gas Electric Light & Power Co. of Baltimore
531 E. Madison St.
Zapffe, Carl A.
Consulting Metallurgical Engineer
6410 Murray Hill Rd.
Zeidler, William H.
Chesapeake & Potomac Telephone Co. of Baltimore
320 St. Paul St.

MASSACHUSETTS

BOSTON
Bird, J. D.
The Dampney Co. of America
Hyde Park
Cushing, Daniel
Consulting Engineer
148 State St.
Rue, Edward C.
Boston Edison Co.
39 Boylston St.
Spring, Harry M., Jr.
Mutual Boiler Insurance Co. of Boston
60 Batterymarch St.
Wood, Paul E.
General Electric Co.
136 Federal St.

CAMBRIDGE
Brasunas, Anton D.
Corrosion Laboratory
Massachusetts Institute of Technology
Davis, F. W.
E. B. Badger & Sons Co.
260 Bent St.
Uhlig, H. H.
Corrosion Laboratory
Massachusetts Institute of Technology

PITTSFIELD
Brush, Edwin G.
General Electric Co.
Bldg. 2, 1 Plastics Ave.

QUINCY
Mosher, L. Malcolm
Bethlehem Steel Corp.
Shipbuilding Division

READING
Wheeler, Roger M.
Sohio Pipeline Co.
186 High St.

SOUTH BOSTON
Sherwood, William C.
Hersey Manufacturing Co.
Corner E & Second Sts.

WALTHAM
Karraker, Edward L., Jr.
Shell Oil Co., Inc.
Box 181

WATERTOWN
Jacobson, Murray
Watertown Arsenal

MICHIGAN

BATTLE CREEK
Blaese, Arnold C.
Hughes Brothers
100 N. McKinley St.

BIG RAPIDS
Thompson, J. B.
Michigan Consolidated Gas Co.
218 Maple St.

DEARBORN
McKenzie, T. Curtis
Klem Chemical Works
14401 Lanson St.

DETROIT
Cavanagh, W. R.
Parker Rust Proof Co.
2177 Milwaukee St.
Clayton, William J.
Minnesota Mining & Manufacturing Co.
411 Piquette Ave.
Coley, Glenn
The Detroit Edison Co.
2000 Second Ave.
Fraser, William R.
Michigan Consolidated Gas Co.
415 Clifford
Kennedy, Ted
Dearborn Chemical Co.
3240 Book Tower
Lo Prete, Jack H.
Spray-Coat Engineers, Inc.
8711 W. Chicago Blvd.
Nielsen, Claudius
Nielco Laboratories
8129 Lyndon St.
Pinner, W. L.
Houdaille Hershey Corp.
9120 Roselawn
Sanderson, Wiley D.
The Detroit Edison Co.
2000 Second Ave.
Saulson, Saul
Albert Kahn Associated Architects & Engineers, Inc.
New Center Bldg.
Walker, Henry S.
The Detroit Edison Co.
2000 Second Ave.
Weigele, T. W.
Michigan Consolidated Gas Co.
415 Clifford St.

JACKSON
Herringshaw, D. E.
Consumers Power Co.
212 W. Michigan Ave.
Kendall, Earl H.
Consumers Power Co.
212 W. Michigan Ave.
O'Brien, Thomas W.
Consumers Power Co.
212 W. Michigan Ave.
Sayles, E. V.
Consumers Power Co.
212 W. Michigan Ave.

MIDLAND
Alquist, F. N.
The Dow Chemical Co.
Colburn, Lyle W.
The Dow Chemical Co.
Hodge, John A., Jr.
The Dow Chemical Co.
Humble, H. A.
The Dow Chemical Co.
Hunter, Ralph M.
The Dow Chemical Co.
Justin, Frank H.
The Dow Chemical Co.
Kirk, E. L.
The Dow Chemical Co.
Robinson, Harold A.
The Dow Chemical Co.
Robinson, Melvin O.
The Dow Chemical Co.
Smith, Arthur, Jr., Mgr.
The Dow Chemical Co.
Yarrington, Donald M., Jr.
The Dow Chemical Co.

Featherly, Robert L.
The Dow Chemical Co.
MT. PLEASANT
Mahoney, E. J. Jr.
Mahoney Contracting Co.
Hersee Bldg.
TRENTON
Hickey, Robert P.
Socony-Vacuum Oil Co., Inc.
Drawer D
VICKSBURG
Ronningen, H. A.
Ronningen Engineering Sales Co.
WAYNE
Garcia, Luis
Transit & Storage Co., Ohio-Michigan Pipe Line Div.
Box 231
WYANDOTTE
Cook, Leon D., Jr.
Wyandotte Chemical Works

MINNESOTA

MINNEAPOLIS
Carter, George M., Jr.
Minneapolis Gas Light Co.
Eighth St. & Marquette Ave.
Frederickson, H. M.
Montana-Dakota Utilities Co.
831 Second Ave. S.
Jacobs, M. L.
Jacobs Wind Electric Co., Inc.
2111 Washington Ave. N.
Kalm, Fred J.
Superior Plating & Rustproofing Co.
1060 Tenth Ave. S. E.
Mann, Charles A.
Department of Chemical Engineering
University of Minnesota
Mattern, R. P.
Minneapolis-Honeywell Regulator Co.
2753 Fourth Ave. S.
Neprude, E. N.
City of Minneapolis Water Department
City Hall Bldg.
Patterson, M. Kingsley
Minneapolis Gas Light Co.
739 Marquette Ave.

MISSISSIPPI

COLUMBUS
Kean, E. E., Jr.
Mississippi Gas Co.
Box 884
JACKSON
James, H. E.
Mississippi Power & Light Co.
Lampton Bldg.
Jones, G. C.
Mississippi Power & Light Co.
Box 1640
MERIDIAN
Griffin, H. K.
Mississippi Gas Co.
Box 1191

MISSOURI

JOPLIN
Musgrave, John R.
The Eagle-Picher Co.
Box 290
KANSAS CITY
Arnoldy, Francis R.
Southwestern Bell Telephone Co.
324 E. 11th St.
Black, Ernest B.
Black & Veatch, Consulting Engineers
4706 Broadway
Buddrus, E.
Panhandle-Eastern Pipe Line Co.
1221 Baltimore Ave.
Busch, Paul E.
Great Lakes Pipe Line Co.
Bryant Bldg.
Church, Laurence T.
Panhandle-Eastern Pipe Line Co.
1221 Baltimore Ave.
Hibbs, Don B.
Cooperative Pipe Line Assoc.
318 E. Tenth St.
Hieronymus, T. G.
Kansas City Power & Light Co.
Box 679
Hummon, C. Gerald
Sheffield Steel Corp.
Sheffield Station
Keane, C. C.
Great Lakes Pipe Line Co.
Drawer 2239
McElhatton, F. J.
Panhandle-Eastern Pipe Line Co.
1221 Baltimore Ave.
Neipp, Howard S.
Owens-Corning Fiberglas Corp.
903 Grand Ave.
Pyott, William T.
Great Lakes Pipe Line Co.
Box 2239
Schuster, Melvin R.
Aluminum Co. of America Power & Light Bldg.
Stutzman, Milo J.
Midwest Research Institute
4049 Penn
Yates, Clarence C.
Southwestern Bell Telephone Co.
Telephone Bldg.
ST. LOUIS
Ferree, Ray J.
National Lead Co.
722 Chestnut St.
Gross, Wm. F.
Tretolite Co.
937 Pacific Ave.
Johannes, E. Gent
Mineral Products Co.
3102 S. Grand
Keller, W. H.
Johns-Manville Sales Corp.
1000 Market St.
Lester, Charles B.
Sohio Pipe Line Co.
407 N. Eighth St.
Lowther, G. B.
Mississippi River Fuel Corp.
407 N. Eighth St.
Lynch, William H.
Barry Wehmiller Machine Co.
4660 W. Florrisant
MacGregor, Alfred H.
Bauer & Black Div. of the Kendall Co.
4 N. Eighth St.
Mange, Clarence E.
C. E. Mange Development Laboratory
4425 Geraldine Ave.
Martin, F. J.
Mississippi River Fuel Corp.
407 Eighth St.
Meyer, Walter
John Nooter Boiler Works Co.
1400 S. Second St.
Rasmussen, V. L.
The Laclede Gas Light Co.
3950 Forest Park Ave.
Richards, Walter C.
A. Leschen & Sons Rope Co.
5909 Kennerly Ave.
Zange, Max
Warwick Hotel
St. Louis, Mo.
Ziebold, H. O.
Mississippi River Fuel Corp.
407 N. Eighth St.
SPRINGFIELD
Dyer, W. S.
Ajax Pipe Line Corp.
Box 1246
Holland, J. B.
Ajax Pipe Line Corp.
Landers Bldg.
UNIVERSITY CITY
Dolson, Frank E., Jr.
St. Louis County Water Co.
6600 Delmar Blvd.
VALLEY PARK
McGrue, W. M.
Universal Atlas Cement Co.
Route 1

MONTANA

BUTTE
Davis, Carl R.
Montana Power Co.
40 E. Broadway
GLENDIVE
Knapp, Frederick F.
Montana-Dakota Utilities Co.
Schroth, Harry A.
Montana-Dakota Utilities Co.
Box 131
Williams, Ernest E.
Montana-Dakota Utilities Co.
Box 351

NEBRASKA

BEATRICE
Krueger, Jess J.
Northern Natural Gas Co.
1708 Grant St.
Marx, Paul F.
Williams Brothers Corp.
Box 232
HASTINGS
Hill, Leonard C.
Kansas-Nebraska Natural Gas Co., Inc.
300 N. St. Joe
OGALLALA
Goodall, R. A.
Good-All Electric Mfg. Co.
112 W. Main St.
Smith, Lyle R.
Good-All Electric Mfg. Co.
112 Main St.

OMAHA
Bruhn, H. W.
Omaha & Council Bluffs Electrolysis Committee
1020 N. 22nd St.
Haas, W. B.
Northern Natural Gas Co.
Aquila Court Bldg.
Johnson, A. G.
Omaha Public Power District
17th & Harney Sts.
Klever, Charles F.
Metropolitan Utilities District
13th & Harney Sts.
Werner, Daniel R.
American Telephone & Telegraph Co.
Telephone Bldg.

NEW JERSEY

BARBER
Reichard, Edmund C.
American Smelting & Refining Co.
BAYONNE
Klinger, O. C.
Oildom Publishing Co.
1217 Hudson Blvd.
McHale, P. J.
General Cable Corp.
Avenue A & First St.
BELLEVILLE
Bart, S. G.
Bart Manufacturing Co.
227 Main St.
Lefebvre, Fabian J.
Electro Rust-Proofing Corp.
1 Main St.
BURLINGTON
Schuh, Arthur E.
United States Pipe & Foundry Co.
CAMDEN
Eddison, Clifford
Radio Corporation of America
Bldg. 7-4
CRANFORD
Copson, Harry R.
International Nickel Co., Inc.
PASSAIC
Everest, Guy N.
The Okonite Co.
ELIZABETH
Fyke, F. C.
Standard Oil Development Co.
Box 37
West, C. H.
Standard Oil Development Co.
Box 37
GRASSELLI
Thiede, Richard C.
General Aniline Works
HADDONFIELD
Davis, Edwin G.
American Telephone & Telegraph Co.
600 Grove St.
HARRISON
Allen, Russell J.
Worthington Pump & Machinery Corp.
Pratt, Ward E.
Worthington Pump & Machinery Corp.
LINDEN
Holmberg, Emil G.
Alloy Steel Products Co.
1300 W. Elizabeth Ave.
MANVILLE
Barbehenn, Ralph L.
Johns-Manville Corp.
Clarvoe, George W.
Johns-Manville Corp.
MAPLEWOOD
Howell, John C.
Public Service Electric & Gas Co.
200 Boyden Ave.
MURRAY HILL
Compton, Kenneth G.
Bell Telephone Laboratories, Inc.
Pearson, E. T.
Public Service Electric & Gas Co.
200 Boyden Ave.
NEWARK
Aldrich, Harold L.
423 Ridge Street
Blake, George H.
Public Service Corp. of New Jersey
80 Park Place
Bonner, W. F.
Federal Telephone & Radio Corp.
200 Mt. Pleasant Ave.
Brookes, A. Sidney
Public Service Electric & Gas Co.
80 Park Place
Carmichael, Elwood T.
Public Service Electric & Gas Co.
80 Park Place
Collins, George J.
Federal Telephone & Radio Corp.
200 Mt. Pleasant Ave.
Hall, Nathaniel
G. B. Hogaboom, Jr. & Co.
44 E. Kinney St.
Harvey, W. J.
Public Service Electric & Gas Co.
80 Park Place
Hutton, H. S.
Wallace & Tiernan Co., Inc.
Box 178
Leedom, Laurie M.
Division of Water, City of Newark, New Jersey
City Hall Annex
MacDonald, F. R., II
Electro Rust-Proofing Corp.
Box 178
Nicolson, H. W.
Public Service Electric & Gas Co.
80 Park Place
Salmon, Philip A.
Public Service Electric & Gas Co.
80 Park Place
Strom, C. F.
American Steel Castings Co.
Ave. L & Herbert St.
Wunderlich, Norman E.
Federal Telephone & Radio Corp.
200 Mt. Pleasant Ave.
NORTH ARLINGTON
Eberhardt, E. T.
Subox, Inc.
348 River Road
PATERSON
Bennett, Charles E.
The Okonite Callender Cable Co., Inc.
730-21st Ave.
Garrison, V. L.
The Okonite Callender Cable Co., Inc.
730-21st Ave.
PHILLIPSBURG
Cann, Kenneth R.
Ingersoll-Rand Co.
Crobaugh, Albert O.
Ingersoll-Rand Co.
Godshall, J. Byron
Ingersoll-Rand Co.
PRINCETON
Goldowski, N.
239 Nassau St.
RED BANK
Guerry, William A.
U. S. Army Transportation Corps Board
42 Pinkney Road
TRENTON
Suverkrop, E. A.
John A. Roebling's Sons Co.
640 S. Broad St.
Alexander, Robert O.
Thiokol Corp.
780 N. Clinton Ave.
WEEHAWKEN
Alfke, C. J.
Hackensack Water Co.
4100 Park Ave.
WESTFIELD
Crane, Harold E., Jr.
Koppers Co., Inc., Wailes Dove-Hermiston Dept.,
449 South Ave.
Stromquist, R. C.
Koppers Co., Inc., Wailes Dove-Hermiston Dept.,
449 South Ave.
Thornhill, W. H. T.
Koppers Co., Inc., Wailes Dove-Hermiston Dept.,
449 South Ave.
Yeazel, F. C.
Pipe Line Service Corp.
681 Dorian Road

NEW MEXICO

ALBUQUERQUE
Peacore, O. B.
Southern Union Gas Co.
Box 1692
Wilson, T. A.
Southern Union Gas Co.
Box 1692
CARLSBAD
Holt, James B.
International Minerals & Chemical Corp.

NEW YORK

BRONXVILLE
Schultz, Wayne H.
Hill, Hubbell Co. Div. General Paint Corp.
1342 Midland Ave.
BROOKLYN
Bermann, Morton
The Brooklyn Union Gas Co.
197 St. James Place
Christ, George J.
New York Telephone Co.
101 Willoughby

Diehlman, George
National Lead Co.
105 York St.

Goldsmith, Clarence S.
The Brooklyn Union Gas Co.
176 Remsen St.

Hawke, David L.
National Lead Co.
105 York St.

Kleinheksel, S.
Socony-Vacuum Oil Co., Inc.
412 Greenpoint Ave.

Ruffing, Frank M.
Magnolia Products Co., Inc.
139 Banker St.

Shaw, William E.
National Lead Co.
105 York St.

Stewart, Alex
National Lead Co.
105 York St.

Thompson, Charles H.
New York Telephone Co.
101 Willoughby St.

Wilkinson, Horatio L.
The Debevoise Co.
968 Grand St.

Zahn, Harold F.
National Lead Co.
105 York St.

BUFFALO

Nicholson, C. T.
Buffalo Niagara Electric Corp.
Electric Bldg.

ITHACA

Stillman, De Witt S., Jr.
Cornell University
1 Forest Park Lane

LONG ISLAND CITY

Gray, A. E.
Pipe Protection Service Co.
2616 Skillman Ave.

Hall, Kenneth G.
Pipe Protection Service Co.
2616 Skillman Ave.

Staiti, J. J.
General Chemical Co.
Box 149

Sterne, Cecil M.
Metropolitan Refining Co., Inc.
50-23 23rd St.

NEW YORK

Andrew, Harold O.
Robbins Publishing Co.
9 E. 38th St.

Bagnell, William E.
Ebasco Services, Inc.
2 Rector St.

Baker, Henry F.
Corrosite Corp.
405 Lexington Ave.

Baker, Ralph D.
National Lead Co.
111 Broadway

Baldwin, L. A.
Johns-Manville Sales Corp.
22 E. 40th St.

Battle, Thomas J.
Koppers Co., Inc., Wailes Dove-Hermiston Dept.
629 W. 115th St.

Blenheim, D. E.
American Telephone & Telegraph Co.
140 West St.

Boyd, George E.
Koppers Co., Inc., Wailes Dove-Hermiston Dept.
17 Battery Place

Bruley, Robert W.
Koppers Co., Inc., Wailes Dove-Hermiston Dept.
17 Battery Place

Carr, Reid L.
Columbian Carbon Co.
41 E. 42nd St.

Champlin, George D. L.
Standard Oil Development Co.
30 Rockefeller Plaza

Church, Herbert M., Jr.
Lead Industries Assoc.
420 Lexington Ave.

Devoluy, Raymond
C. A. Woolsey Paint & Color Co., Inc.
229 E. 42nd St.

Dewey, William S.
New York Telephone Co.
140 West St.

Donovan, Lewis B.
Consolidated Edison Co.
4 Irving Place

Faires, Carl D.
Shell Oil Co., Inc.
50 W. 50th St.

Feller, Eugene W. F.
McGraw-Hill Publishing Co.
330 W. 42nd St.

Fetter, E. C.
Chemical Engineering
330 W. 42nd St.

Friend, W. Z.
The International Nickel Co., Inc.
67 Wall St.

Friz, Nelson
Standard Oil Co. of New Jersey
26 Broadway

Goldsby, Fred L.
Chicago Bridge & Iron Co.
165 Broadway

Gorman, L. J.
Consolidated Edison Co. of New York, Inc.
4 Irving Place

Graham, S. B.
American Telephone & Telegraph Co.
195 Broadway

Henderson, James B.
DryNamic Division, Cargocaire Engineering Corp.
15 Park Row

Henderson, Walter A.
New York Telephone Co.
140 West St.

Heverly, L. F.
Ebasco Services, Inc.
2 Rector St.

Hills, R. C.
Freeport Sulphur Co.
122 E. 42nd St.

Huntley, Harold R.
American Telephone & Telegraph Co.
195 Broadway

Johnston, Howard E.
Dearborn Chemical Co.
205 E. 42nd St.

Jordan, Harry E.
American Water Works Assoc.
500 Fifth Ave.

Kellogg, Markoe O.
Shell Oil Co., Inc.
50 W. 50th St.

Klein, Fred M.
Maurice A. Knight Co.
55 W. 42nd St.

Koester, Henry F.
Consolidated Edison Co. of New York, Inc.
708 First Ave.

Kulman, Frank E.
Consolidated Edison Co. of New York, Inc.
4 Irving Place

Lain, George D.
American Iron & Steel Institute
350 Fifth Ave.

LaQue, F. L.
The International Nickel Co., Inc.
67 Wall St.

Maitland, T. J.
American Telephone & Telegraph Co.
32 Sixth Ave.

Marshall, Dwight
St. Joseph Lead Co.
250 Park Ave.

Mason, John F., Jr.
The International Nickel Co., Inc.
67 Wall St.

Maurer, Keith L.
Bell Telephone Laboratories, Inc.
463 West St.

McComb, George B.
Barrett Division, Allied Chemical & Dye Corp.
40 Rector St.

Miller, M. C.
Ebasco Services, Inc.
2 Rector St.

Morse, Robert E.
American Gas & Electric Service Corp.
30 Church St.

Morton, B. B.
The International Nickel Co., Inc.
67 Wall St.

Nill, Edwin P.
Consolidated Edison Co. of New York, Inc.
708 First Ave.

Nolan, Vincent J.
National Carbon Co.
30 E. 42nd St.

Noppel, E. P.
Ebasco Services, Inc.
2 Rector St.

Peabody, A. W.
Ebasco Services, Inc.
2 Rector St.

Perry, C. B.
Westinghouse Electric International Co.
40 Wall St.

Peters, Fred P.
Reinhold Publishing Corp.
330 W. 42nd St.

Pettee, Allen D.
General Cable Corp.
420 Lexington Ave.

Pope, Robert
Bell Telephone Laboratories, Inc.
463 West St.

Priestley, Henry L.
Electro Metallurgical Co.
30 E. 42nd St.

Rhodes, George I.
Ford, Bacon & Davis, Inc.
39 Broadway
Rinehart, Evan
Johns-Manville
22 E. 40th St.
Robson, Arthur D.
Koch Brothers, Inc.
2600 Richmond Terrace
Staten Island
Semple, Clarence H.
The International Nickel Co., Inc.
67 Wall St.
Sands, George A.
Union Carbide & Carbon Corp.
30 E. 42nd St.
Scarola, V. J.
Eastern Sales & Service Engineers
1341 Gunther Ave.
Shaw, George E.
Oliver United Filters, Inc.
63 W. 42nd St.
Sheldener, Henry L.
Water Service Laboratories
423 W. 126th St.
Smith, Sydney S.
Shell Oil Co., Inc.
50 W. 50th St.
Standring, J. M.
American Telephone & Telegraph Co.
195 Broadway
Taylor, Thomas A.
American Telephone & Telegraph Co.
195 Broadway
Thalmann, E. H.
Ebasco Services, Inc.
2 Rector St.
Tibbetts, E. F.
The Lummus Co.
420 Lexington Ave.
Tice, E. Allen
The International Nickel Co., Inc.
67 Wall St.
Tour, Sam
Sam Tour & Co., Inc.
44 Trinity Place
Trueblood, H. M.
Bell Telephone Laboratories, Inc.
463 West St.
Tsunoda, Kenneth
Hydrocarbon Research, Inc.
115 Broadway
Van Houten, Leslie P.
American Telephone & Telegraph Co.
100 William St.
Vanick, James S.
The International Nickel Co., Inc.
67 Wall St.
Van Vliet, R.
New York & Richmond Gas Co.
691 Bay St., Staten Island
Voigt, Lorraine R.
The International Nickel Co., Inc.
67 Wall St.
Wahlquist, Hugo W.
Ebasco Services, Inc.
2 Rector St.
Walczak, M. R.
Barrett Division, Allied Chemical & Dye Corp.
40 Rector St.
Welch, C. G.
The Aquatec Corp.
545 Fifth Ave.
Whiting, L. R.
Bakelite Corp.
30 E. 42nd St.
Wilson, J. B.
Barrett Division, Allied Chemical & Dye Corp.
40 Rector St.
Woody, Charles L.
Ebasco Services, Inc.
2 Rector St.
Zahniser, Arthur N.
Koppers Co., Inc., Wailes Dove-Hermiston Dept.
17 Battery Place

NIAGARA FALLS
Shields, James E.
Alox Corp.
3943 Buffalo Ave.

OSSINING
Mathers, W. D.
Aluminum Co. of America
240 Spring St.

ROCHESTER
Branson, Edward H.
General Railway Signal Co.
801 West Ave.
Crofts, E. R.
Rochester Gas & Electric Corp.
89 East Ave.
East, Leo H.
Rochester Gas & Electric Corp.
89 East Avenue
Fuller, Lawrence F.
Elastic Porcelain Lining Corp.
131 Selye Terrace
Kruger, R. E.
Rochester Gas & Electric Corp.
89 East Avenue
McCumber, Ralph H.
Rochester Gas & Electric Corp.
89 East Avenue
Shnidman, Louis
Rochester Gas & Electric Corp.
89 East Avenue

ROME
Lynes, Wilson
Revere Copper & Brass, Inc.

SCHENECTADY
Mengel, Arthur C.
American Locomotive Co.
North Jay St.

SPRING VALLEY
Seifried, Dean B.
Rockland Gas Co., Inc.
40 Lawrence St.

SYRACUSE
James, Paul W.
San-Equip, Inc.
E. Brighton & Glen Ave.
Moran, T. C.
Central New York Power Corp.
300 Erie Blvd., W.

NORTH CAROLINA

ASHEVILLE
Cobb, Stephen P.
Ebasco Services, Inc.
1 Country Club Rd.

OHIO

AKRON
Funk, F. W.
Ohio Edison Co.
47 N. Main St.
Siddall, D. F.
The United States Stoneware Co.
Box 350

BARBERTON
Bronstein, Emanuel H.
The Ric-Wil Co.
Gegner, Paul J.
Pittsburgh Plate Glass Co.

CANTON
Clark, Claude L.
Timken Roller Bearing Co.

CINCINNATI
Goetz, Alvin C.
The Eagle-Picher Co.
American Bldg.
Malcom, V.
The Philip Carey Mfg. Co.
Anthony Wayne Ave.
Nuezel, E. F.
Cincinnati Gas & Electric Co.
323 Plum St.
Pfeiffer, Milton J.
Cincinnati Gas & Electric Co.
Box 960
Schreiner, William J.
Cincinnati Gas & Electric Co.
323 Plum St.

CLEVELAND
Bixby, Willard F.
B. F. Goodrich Chemical Co.
Rose Bldg.
Bowen, Milton M.
Hill-Hubbell Division, General Paint Corp.,
3091 Mayfield Rd.
Carson, John H.
The East Ohio Gas Co.
1405 E. Sixth St.
Connelly, D. J.
Williams & Co., Inc.
3700 Perkins Ave.
Craver, Albert F.
The Cleveland Heater Co.
2310 Superior Ave.
Daugherty, M. W.
Aluminum Co. of America
2210 Harvard Ave.
Davis, L. W.
Aluminum Co. of America
2210 Harvard Ave.
Dyble, Edward
General Motors Corp.
2160 W. 106th St.
Febrey, H. H.
American Steel & Wire Co.
Rockefeller Bldg.
Fergus, D. J.
The Cleveland Heater Co.
2310 Superior Ave.
Gosnell, Everett C.
The Colonial Iron Works Co.
17643 St. Clair Ave.
Heil, Carl E.
Heil Process Equipment Corp.
12901 Elmwood Ave.
Hoxeng, R. B.
Case Institute of Technology
University Circle

Kamps, Julius W.
Koppers Co., Inc., Wailes Dove-Hermiston Dept.
Union Commerce Bldg.

Kerns, Everette E.
Standard Oil Co. of Ohio
Midland Bldg.

Loucks, Charles M.
Dowell, Inc.
Terminal Tower Bldg.

Martin, Wayne E.
National Smelting Co.
6700 Grant Ave.

Mills, Lester D., Jr.
Standard Oil Co. of Ohio
Midland Bldg.

Oliver, J. Paul
National Carbon Co.
W. 117th & Madison

Penske, J. H., Jr.
Williams & Co. Inc.
3700 Perkins Ave.

Peters, E. Donald
The Colonial Iron Works Co.
17643 St. Clair Ave.

Prescott, Joseph
Cleveland Electric Illuminating Co.
75 Public Square

Richards, R. J.
Coatings For Industry, Inc.
2185 E. 18th St.

Ricksecker, Ralph E.
Chase Brass & Copper Co., Inc.
1155 Babbitt Road

Sandel, Walter J.
Coatings For Industry, Inc.
2185 E. 18th St.

Scanlon, D. A.
American Steel & Wire Co.
614 Superior Ave.

Spahr, C. E.
Sohio Pipe Line Co.
Midland Building

Stern, Allan P.
The Colonial Iron Works Co.
17643 St. Clair Ave.

Sutliff, James E.
Coatings For Industry, Inc.
2185 E. 18th St.

Vandaveer, F. E.
The East Ohio Gas Co.
E. 63rd St., N. of St. Clair Ave.

Vereeke, Edwin W.
Heil Process Equipment Corp.
12901 Elmwood Ave.

Warner, Clarence J.
The Colonial Iron Works Co.
17643 St. Clair Ave.

Whitacre, Charles H.
Standard Oil Co. of Ohio
Midland Bldg.

Young, Robert J.
Hill-Hubbell & Co. Division General Paint Corp.
3091 Mayfield Road

COLUMBUS

Beck, Franklin H.
The Ohio State University Engineering Experiment Station

Beitler, Gerald S.
The Ohio Fuel Gas Co.
99 N. Front St.

De Mey, C. F.
Columbia Engineering Corp.
99 N. Front St.

Feldman, Karl T.
Sinclair Refining Co.
Huntington Bank Bldg.

Fink, Frederick W.
Battelle Memorial Institute
505 King Ave.

Fontana, Mars G.
The Ohio State University Engineering Experiment Station

Gow, James T.
Battelle Memorial Institute
505 King Ave.

Herndon, L. Kermit
The Ohio State University
Box 3137

Hoover, Charles P.
928 Dublin Road

Kretschmer, William J.
Columbia Engineering Corp.
99 N. Front St.

Lintelman, Warren F.
Sinclair Refining Co. of Ohio
Huntington Bank Bldg.

Pray, H. A.
Battelle Memorial Institute
505 King Ave.

Riddle, H. S.
Columbia Engineering Corp.
99 N. Front St.

Sims, Chester T.
Battelle Memorial Institute
505 King Ave.

DAYTON

Luce, Walter A.
The Duriron Co., Inc.
Box 1019

Michael, Lewis E.
31 S. Willow Grove Ave.

Ohmer, George H.
Galv-Weld Products Co.
Box 37, Station D.

Stephenson, R. B.
Dayton Power & Light Co.
25 N. Main St.

Sudrabin, Leon P.
Electro Rust-Proofing Corp.
860 W. Riverview Ave.

FAIRPORT

McIlrath, Samuel W.
Diamond Alkali Co.

FINDLAY

Slough, Ralph M.
The Ohio Oil Co.
539 S. Main St.

GIRARD

Morain, Jack F.
Hill, Hubbell & Co., Division, General Paint Corp.
Box 299

LIMA

Moffett, J. L.
The Ohio Oil Co.
Box 719

Tappy, Kenneth E.
The Ohio Oil Co.
Box 719

MANSFIELD

Kaufman, L. W.
Westinghouse Electric Corp.
200 E. Fourth St.

MARION

Feldman, Karl T.
Sinclair Refining Co.
139 N. State St.

MIDDLETOWN

Beam, Russell C.
Armco Drainage & Metal Products, Inc.
703 Curtis St.

Thomas, Arba H.
The American Rolling Mill Co.
703 Curtis St.

NEWARK

Hunter, Wesley L.
Pure Oil Co.
Heath Refinery

PAINESVILLE

Campbell, C. Langdon
Diamond Alkali Co.

SHARONVILLE

Miller, Robert D.
Electric Auto-Lite Co.

TOLEDO

Myers, Frank L.
Owens-Corning Fiberglas Corp.
Nicholas Bldg.

Peek, Sam M.
Owens-Corning Fiberglas Corp.
Nicholas Bldg.

YOUNGSTOWN

Flickinger, L. C.
The Youngstown Sheet & Tube Co.
Campbell Works

Reinhardt, G. A.
The Youngstown Sheet & Tube Co.

OKLAHOMA

BARTLESVILLE

Briggs, Clay
Empire Pipeline Co.
Masonic Bldg.

Bryan, Lloyd
H. C. Price Co.
Box 149

Buff, B. F.
National Zinc Co., Inc.

Dewar, J. S.
H. C. Price Co.
Box 149

Fleming, Max Charles
Phillips Petroleum Co.

Holmberg, M. E.
Phillips Petroleum Co.

Huddleston, Wm. E.
Huddleston Engineering Co.
Box 998

Hugo, L. A.
Phillips Petroleum Co.

Kindsvater, E. F.
Phillips Petroleum Co.

Neill, James P.
H. C. Price Co.
Box 149

Owens, Earl O.
Cities Service Gas Co.

Tietze, I. B.
Phillips Petroleum Co.
Drawer B

CUSHING

Nelson, Lloyd B.
Shell Pipe Line Corp.
701 S. Cleveland St.

CYRIL

Fryer, Carl V.
Anderson Prichard Oil Corp.

ENID
Keepers, Guy S.
Champlin Refining Co.
Box 552
Wilmoth, E. G.
Champlin Refining Co.
Box 552
GUTHRIE
Kahan, Merle W.
Guthrie Gas Utilities Co.
Box 814
OKLAHOMA CITY
Baird, Geo. H.
Cities Service Gas Co.
First National Bldg.
Blair, John V.
Sinclair Prairie Oil Co.
Colcord Bldg.
Carmichael, J. D.
Cathodic Servicing Co.
Box 3737
Carmichael, Miles
Cathodic Servicing Co.
Box 3737
Coursey, Ralph W.
Oklahoma Gas & Electric Co.
321 N. Harvey
Haltom, J. Myrl
Dearborn Chemical Co.
7102 N. May Ave.
Kopp, C. H.
Peppers Refining Co.
S. E. 12th & High Sts.
Lima, D. O.
Oklahoma Gas & Electric Co.
Box 1498
Raymond, Gwynne
Black Sivalls & Bryson
Box 1714
Riseling, T. M.
Electro Rust-Proofing Corp.
936 N. E. 15th St.
Wallace, William P.
Kobe, Inc.
230 S. E. 29th St.
Walter, R. B.
McRay Products Co.
Box 5236
PONCA CITY
Secrest, Leslie C.
Continental Pipe Line Co.
Wilson, Sid W.
Wilson Electric Co.
Box 588
TULSA
Aude, T. R.
Stanolind Pipe Line Co.
Box 591
Austin, Raymond A.
Southwestern Bell Telephone Co.
220 S. Owasso
Avey, Dan M.
Alox Sales Co.
Box 1914
Ayers, E. B.
Perrault Brothers
1130 N. Boston Ave.
Bardsley, Bo
Crutcher-Rolfs-Cummings
Box 2398
Barrett, Jack P.
Stanolind Oil & Gas Co.
1136 N. Lewis St.
Bossard, Le Roy T.
Stanolind Oil & Gas Co.
Box 591
Bruner, Max
The Refining Engineering Co.
Box 1977
Bullock, Robert L.
Interstate Oil Pipe Line Co.
Box 1349
Cardwell, Paul H.
Dowell Inc.
Kennedy Bldg.
Clark, Robert E.
Natasco Co.
Box 1318
Cloninger, Fred M.
The Texas Pipe Line Co.
2434 E. Eighth St.
Cloud, C. E.
Oklahoma Natural Gas Co.
624 S. Boston Ave.
Cooley, Herbert M.
Bethlehem Steel Co.
Box 2171
Cowles, James R.
Oklahoma Natural Gas Co.
Box 871
Crowe, Raymond H.
Stanolind Pipe Line Co.
Box 591
Curran, Michael
M. J. Crose Co.
Davis, P. F.
The Texas Pipe Line Co.
Box 2420
Ewing, Scott P.
Carter Oil Co.
Box 801
Fulton, Walter B.
Interstate Oil Pipe Line Co.
National Bank of Tulusa Bldg.
Gardner, Franklin T.
University of Tulsa
Gibbon, Anthony
The Oil Weekly
Hunt Bldg.
Gibbons, Harry J.
Skelly Oil Co.
Box 1650
Glandon, G. O.
Midwestern Engine & Equipment Co., Inc.
105 N. Boulder Ave.
Glasgow, Clarence O.
National Tank Co.
Drawer 1710
Good, Donald B.
The Texas Pipe Line Co.
Box 2420
Harrison, Scott J.
Metal Goods Corp.
Drawer 2519
Harshman, J. B.
Stanolind Pipe Line Co.
Box 591
Horne, Albert N.
Texas-Empire Pipe Line Co.
Kaster, J. W.
Oklahoma Natural Gas Co.
624 S. Boston Ave.
Kelly, R. W.
Dearborn Chemical Co.
Midco Bldg.
King, Clyde A., Jr.
King Pipe Coating & Wrapping Co.
Hunt Bldg.
Laster, Gaines
Barrett Division, Allied Chemical & Dye Corp.
403 S. Indianapolis St.
Lavery, C. A.
National Tank Co.
Drawer 1710
Liggett, Ernest J.
Johns-Manville Sales Corp.
Box 2239
Manley, Harold W.
Barnsdall Oil Co.
Box 2039
McNulty, Frank E.
Koppers Co., Inc., Wailes Dove-Hermiston Dept.
310 Thompson Bldg.
Menaul, Paul L.
Stanolind Oil & Gas Co.
Box 591
Montgomery, C. W.
Natasco Co.
Box 1318
Munneke, A. S.
Stanolind Pipe Line Co.
Box 591
Murrey, O. E.
Midwestern Engine & Equipment Co., Inc.
105 N. Boulder Ave.
Norberg, H. A.
Nelson Electric Mfg. Co.
217 N. Detroit
Perrault, Lewis
Perrault Brothers
1130 N. Boston Ave.
Pyeatt, F. E., Jr.
Mid-Continent Pipe Line Co.
Box 381
Roddy, David F.
The Texas Pipe Line Co.
Box 2420
Secrest, William F.
Barrett Division, Allied Chemical & Dye Corp.
403 S. Indianapolis St.
Shackelford, Robert E.
Perrault Brothers
1130 N. Boston Ave.
Sidwell, Carroll V.
Sidwell Engineering Co.
Box 4037
Smith, Rex L.
Skelly Oil Co.
Box 1650
Stirling, J. C.
Stanolind Pipe Line Co.
Box 591
Stivers, F. A.
The Texas-Empire Pipe Line Co.
Box 2420
Texter, H. G.
Spang-Chalfant Division, National Supply Co.
National Bank of Tulsa Bldg.
Titterington, Y. W.
Dowell, Inc.
Kennedy Bldg.
Williamson, T. D.
T. D. Williamson, Inc.
3018 E. 15th St.
Williamson, T. D., Jr.
T. D. Williamson, Inc.
3018 E. 15th St.

PENNSYLVANIA

ALLENTOWN
Shafer, A. E. M.
Pennsylvania Power & Light Co.
9th & Hamilton Sts.
AMBRIDGE
Loschiavo, George P.
419 Elm Road
Story, Edward B.
A. M. Byers Co.
Box 269

BETHLEHEM
Frye, S. C.
Bethlehem Steel Co.
701 E. Third St.
Mancke, Edgar B.
Bethlehem Steel Co.
Streicher, Michael A.
Lehigh University
224 Warren Square

BRACKENRIDGE
Kiefer, George C.
Allegheny Ludlum Steel Corp.

BRADFORD
Szekely, George E.
Dresser Mfg. Division.
Dresser Industries, Inc.
41 Fisher Ave.

BRIDGEVILLE
Fulton, L. S.
Universal-Cyclops Corp.
Station St.

CHESTER
Pearson, J. M.
Sun Oil Co.

COATESVILLE
Powers, William J.
Lukens Steel Co.

DREXEL HILL
Fox, R. W.
935 Drexel Ave.

EAST PITTSBURGH
Camp, Eldridge K.
Westinghouse Electric Corp.
Dean, D. W.
Westinghouse Electric Corp.

EDGEWORTH
Tator, Kenneth
Industrial Lining Engineers, Inc.

EDGEWORTH SEWICKLEY
Hammond, Milton B.
Standard Steel Spring Co.
317 Meadow Lane

GLASSPORT
Jensen, Claude H.
Copperweld Steel Co.

GLENWILLARD
Coe, Russell H.
Pipe Line Service Corp.

GREENSBURGH
Curran, James J.
Walworth Huff Co.

HARRISBURG
Iles, John T.
The Bell Telephone Co. of Pennsylvania
210 Pine St.
Tracey, Edward J. J., Jr.
Aircraft-Marine Products Inc.
323 S. Cameron St.

HATBORO
Berkenstock, H. R.
Roberts & Mander Stove Co.
Jacksonville Road

HOLMES
Richard, Charles S.
Socony-Vacuum Oil Co.
Box 229

HOLTWOOD
Sherer, Clayton M.
Pennsylvania Water & Power Co.

MARCUS HOOK
Bagsar, A. B.
Sun Oil Co.

McKEESPORT
Couy, C. J.
Duquesne Light Co.
139 Atlantic Ave.

MEDIA
Burtis, Theodore A.
Owens-Corning Fiberglas Corp.
Bobbin Mill Road

NEW KENSINGTON
Binger, Wayne W.
Aluminum Co. of America
Box 772
Brown, R. H.
Aluminum Co. of America
Box 772
English, Gyme C.
Aluminum Co. of America
Box 772
McKee, A. B.
Aluminum Co. of America
Box 772
Reid, Keith K.
Aluminum Co. of America
Box 772
Verink, Ellis D., Jr.
Aluminum Co. of America
Box 1012
Wagner, R. H.
Aluminum Co. of America
Box 772

NORWOOD
West, Lewis H.
500 Welcome Ave.

PALMERTON
Anderson, Edmund Arnold
The New Jersey Zinc Co. of Pennsylvania
Nelson, Harley A.
The New Jersey Zinc Co. of Pennsylvania

PHILADELPHIA
Anderson, H. Bruce
The Philadelphia Gas Works Co.
1800 Ninth St.
Coleman, W. B.
W. B. Coleman Co.
Ninth & Rising Sun Ave.
Corkran, Austin G.
Texas Eastern Transmission Corp.
5430 Wayne Ave.
Curll, Vincent A.
Pennsylvania Salt Mfg. Co.
Widener Bldg.
Dewar, William
Ralph N. Rulon Inc.
3900 N. Second St.
Donnelly, Joseph B.
Dept. of City Transit, City of Philadelphia
City Hall Annex
Eaches, Albert R.
Philadelphia Electric Co.
Sixth & Chestnut Sts.
Gardiner, J. W., Jr.
John T. Lewis & Bros. Co.
Widener Bldg.
Godshalk, James B.
Fox Products Co.
4720 N. 18th St.
Grader, K. W.
Metalweld, Inc.
26th & Hunting Park Ave.
Hadley, Raymond F.
Susquehanna Pipe Line Co.
1608 Walnut St.
Hamilton, Hugh L.
Keystone Pipe Line Co. & Buffalo Pipe Line Corp.
260 S. Broad St.
Hess, Albert W.
Reynolds Metals Co.
1600 Arch St.
Hort, Percy
Keystone Pipe Line Co.
260 S. Broad St.
Jones, Charles C.
Philadelphia Gas Works Co.
1800 N. 19th St.
Kahler, H. Lewis
W. H. & L. D. Betz
Gillingham & Worth Sts.
Kahn, Frank
Philadelphia Electric Co.
2301 Market St.
Keller, Richard M.
Keystone Pipe Line Co. & Buffalo Pipe Line Corp.
260 S. Broad St.
Lynch, Robert H.
Keystone Pipe Line Co.
260 S. Broad St.
McConomy, Henry F.
The Atlantic Refining Co.
3144 Passyunk Ave.
Meadows, E. L.
Susquehanna Pipe Line Co.
1608 Walnut St.
Miller, Carl F., Jr.
Susquehanna Pipe Line Co.
1608 Walnut St.
Nelson, H. Lloyd
United States Pipe & Foundry Co.
Lincoln Liberty Bldg.
Ott, Robert J.
The Philadelphia Gas Works Co.
5150 N. Sixth St.
Schauers, Joseph A.
Keystone Pipe Line Co.
260 S. Broad St.
Sheen, Robert T.
Milton Roy Pumps
1300 E. Mermaid Ave.
Smith, A. V.
1617 Pennsylvania Blvd.
Sosnin, H. A.
Stanley G. Flagg & Co., Inc.
1421 Chestnut St.
Turner, C. D.
Koppers Co., Inc., Wailes Dove-Hermiston Dept.
401 N. Broad St.
Van de Water, Donald F.
Susquehanna Pipe Line Co.
1608 Walnut St.
Welker, John W.
Milton Roy Pumps
1300 E. Mermaid Ave.
Williams, J. M.
Keystone Pipe Line Co.
260 S. Broad St.
Wilson, Percy S.
The Gregg Co.
1418 Walnut St.
Young, Frank A.
Susquehanna Pipe Line Co.
1608 Walnut St.

PITTSBURGH
Bialosky, Jerome M.
Carnegie-Illinois Steel Corp.
210 Semple St.
Braun, F. C.
Gulf Oil Corp.
Gulf Bldg.
Costanzo, Frank E.
Manufacturers Light & Heat Co.
Union Trust Bldg.

Cox, Edwin S.
The Bell Telephone Co. of Pennsylvania
416 Seventh Ave.

Dickson, C. A., Jr.
The Peoples Natural Gas Co.
545 William Penn Place

Eben, Melville W.
Duquesne Light Co.
435 Sixth Ave.

Kendall, V. V.
National Tube Co.
Box 266

Kennedy, Harvey T.
Gulf Research & Development Co.
Drawer 2038

Kopetz, Geo. E.
Chemical Plants Division, Blaw-Knox Construction Co.
Box 5087, East Liberty Station

Matheson, E. E.
Nordstrom Valve Division, Rockwell Mfg. Co.
400 N. Lexington Ave.

Mears, R. B.
Carnegie-Illinois Steel Corp.
210 Semple St.

Peifer, Norman P.
Manufacturers Light & Heat Co.
Union Trust Bldg.

Pogacar, Charles F.
Mellon Institute of Industrial Research
University of Pittsburgh

Redington, H. Ray
National Tube Co.
Box 266

Redman, Franklin T.
Hall Laboratories
323 Fourth Ave.

Rimbach, Richard
Consulting Engineer
1117 Wolfendale St.

Romig, O. E.
Carnegie-Illinois Steel Corp.
210 Semple St.

Seagren, G. W.
Mellon Institute of Industrial Research
University of Pittsburgh

St. Clair, John C.
Blaw-Knox Construction Co.
Box 1198

Speller, Frank N.
Consulting Engineer
6411 Darlington Road

Swensson, Stuart J.
American Hot Dip Galvanizers Association, Inc.
First National Bank Bldg.

Vaurio, V. W.
Carnegie-Illinois Steel Corp.
210 Semple St.

Wescott, Blaine B.
Gulf Research & Development Co.
Drawer 2038

Young, George H.
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4400 Fifth Ave.

PORT ALLEGANY

Isherwood, J. H.
North Penn Gas Co.
76-80 Mill St.

STATE COLLEGE

Read, Harold J.
Department, Mineral Technology
Pennsylvania State College

VANDERGRIFT

Larrabee, C. P.
Carnegie-Illinois Steel Corp.

VILLANOVA

Nelson, T. H.
T. H. Nelson Research Laboratories

WILKES-BARRE

Evans, Rulison
Scranton-Spring Brook Water Service Co.
30 N. Franklin St.

WILLIAMSPORT

Hur, J. James
Atlantic Refining Co.
332 Mulberry St.

SOUTH CAROLINA

GREENVILLE

Bull, Irving Stuart, Jr.
Dunean Mills

SOUTH DAKOTA

ELK POINT

Lutjens, Fred H.
South Dakota Public Service Co.
Box 496

TENNESSEE

CHATTANOOGA

Derrick, H. R.
Chattanooga Gas Co.
811-13 Broad St.

MEMPHIS

Riley, W. A.
Dixie Tank & Bridge Co., Inc.
3523 Lamar Ave.

Stull, Fred D.
Memphis Natural Gas Co.
Sterick Bldg.

OAKRIDGE

Grebe, John J.
The Dow Chemical Co.
114 Everest Circle

TEXAS

AMARILLO

Clifton, W. M.
Canadian River Gas Co.
Box 951

Cox, A. F.
Amarillo Oil Co.
Box 151

Long, Dan P.
The Shamrock Oil & Gas Corp.
Box 631

Roberts, L. J.
Southwestern Public Service Co.
Box 1261

AUSTIN

Cunningham, W. A.
University of Texas
Chemical Engineering Bldg.

Hackerman, Norman
Department of Chemistry
University of Texas

Shock, D. A.
Department of Chemistry
University of Texas

Troupe, Ralph A.
Department of Chemical Engineering
University of Texas

BAYTOWN

Armendt, B. F.
Humble Oil & Renfiing Co.
Box 538

Camp, E. Q.
Humble Oil & Refining Co.
Box 538

Comeaux, Roy V.
Humble Oil & Refining Co.
504 Nebraska

Kelly, C. F.
Humble Oil & Refining Co.
Box 538

Parr, MacGregor A.
Texas Parkerizing Co.
Route 1, Box 281

Phillips, Cecil, Jr.
Humble Oil & Refining Co.
Box 536

Viles, P. S.
Humble Oil & Refining Co.
Box 538

BEAUMONT

Baker, Jesse J.
Magnolia Petroleum Co.
2360 Avenue A

Eckles, W. W.
Gulf States Utilities Co.
Lock Drawer 2951

Myers, G. Frank
G. Frank Myers Co.
Box 868

Stewart, W. H.
Sun Pipe Line Co.
San Jacinto Bldg.

Wright, Nathan E.
Magnolia Petroleum Co.
Box 3311

BIG SANDY

Rook, C. G., Jr.
R. Lacy Refinery, Inc.

BIG SPRING

Thompson, R. W.
Cosden Petroleum Corp.
Box 1311

BISHOP

Levinson, I. S.
Celanese Corp. of America

BRENHAM

Cushman, George A.
Municipal Light & Power System

BROWNSVILLE

Irwin, C. A.
Rio Grande Valley Gas Co.
Fifth & Elizabeth

BRYAN

Unruh, Earl W.
Sinclair Refining Co.
Box 1193

CARTHAGE

Stanton, W. L.
Arkansas Louisiana Gas Co. Box 312

COLLEGE STATION

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COLORADO CITY

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Shell Pipe Line Corp.

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Stratton Pipe Line Corp.
Box 1702

Heinemann, Gustave
Southern Alkali Corp.
Box 1341

Heye, B. F.
Central Power & Light Co.
Box 2121

Hieronymus, Frantz M.
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3037 Topeka St.

Mills, George A.
Central Power & Light Co.
Box 2121

Moffatt, Thomas, Jr.
Southern Alkali Corp.

Rankin, Elbert L.
Republic Pipe Line Co.
Box 2166

Reeb, Fred C.
Pipe Line Service Corp.
Box 578

Richards, S. L., Jr.
Rosson-Richards Co.
Box 908

Rosson, J. H., Jr.
Rosson-Richards Co.
Box 908

Shobe, E. H.
Southern Pipe Line Corp.
411 N. Broadway

Stephenson, G. W.
Southwestern Oil & Refining Co.
Box 1147

Stokes, R. A.
R. A. Stokes, Inc.
635 Nixon Bldg.

DALLAS

Bacon, Thomas S.
Lone Star Producing Co.
1915 Wood St.

Beesley, Glyn W.
Dallas Power & Light Co.
1506 Commerce St.

Boatright, Byron B.
Republic Natural Gas Co.
1505 Federal St.

Book, C. C.
Republic Natural Gas Co.
1505 Federal St.

Curtis, D. A.
Revere Copper & Brass Co.
Tower Petroleum Bldg.

Delf, Leslie E.
Southwest Equipment Co.
919 S. Ervay St.

Elliott, Robert D.
Dallas Power & Light Co.
1506 Commerce St.

Foster, J. L.
Lone Star Gas Co.
1915 Wood St.

Frasch, H. H.
National Carbon Co., Inc.
Irwin-Keasler Bldg.

Gear, Harry C.
Sutton, Steel & Steel, Inc.
1031 S. Haskell

Harber, Thomas W.
Celanese Plastic Corp.
Irwin-Keasler Bldg.

Hughes, H. D.
American Cast Iron Pipe Co.
RFD 7, Box 331

Koepke, Boyd F.
Aluminum Co. of America
Thomas Bldg.

Levy, D. H.
Magnolia Pipe Line Co.
Box 900

McCarthy, Robert A.
Hill, Hubbell Co., Division, General Paint Corp.
6246 Woodland Drive

Minton, John P.
Magnolia Petroleum Co.
Box 900

Neal, James L.
Owens-Corning Fiberglas Corp.
Tower Petroleum Bldg.

Norton, Harry A.
Western Union Telegraph Co.
2030 Main St.

Reid, J. C.
Southern Union Gas Co.
Burt Bldg.

Sims, C. I.
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Southwestern Bell Telephone Co.
308 S. Akard St.

Stratham, Tom R.
Magnolia Pipe Line Co.
Box 900

Thompson, Van
Southern Union Gas Co.
Burt Bldg.

Wahlquist, K. D.
Electro Rust-Proofing Corp.
6281 Revere Place

Williamson, Theodore
Atlantic Pipe Line Co.
Box 2819

Young, C. A.
American Petroleum Institute
Continental Bldg.

DENVER CITY

Cannon, Curtis W.
Frontier Chemical Co.
Box 578

EDNA

Holloway, J. A.
Houston Pipe Line Co.
Box 127

EL PASO

Axelson, G. R.
Pasotex Pipe Line Co.
Box 1022

Emerson, Richard J.
El Paso Natural Gas Co.
Bassett Tower Bldg.

Perkins, C. L.
El Paso Natural Gas Co.
Box 1492

Wainman, L. G.
El Paso Natural Gas Co.
Box 1482

FORT WORTH

Clay, James A., Jr.
Service Engineers, Inc.
First National Bank Bldg.

Cole, Robert M.
Plastic Engineering & Sales Corp.
Box 1037

Cordell, P. M.
Texas Electric Service Co.
Box 970

Davis, James A.
Empire Southern Gas Co.
Box 230

Hess, Fred E.
Fred E. Hess, Inc.
Forth Worth National Bank Bldg.

Johnson, Gerald M.
Sinclair Refining Co.
Fair Bldg.

Ligon, John R.
Sinclair Refining Co.
Fair Bldg.

FREEPORT

Clerc, Milton C.
The Dow Chemical Co.
1407 W. Fourth St.

Fisher, B. M.
Freeport Sulphur Co.
Drawer A

Hart, Porter
The Dow Chemical Co.

Muery, Sam J., Jr.
Freeport Sulphur Co.
Drawer A

Osborn, Oliver
The Dow Chemical Co.

Shigley, C. M.
The Dow Chemical Co.

Works, George A.
The Dow Chemical Co.
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Texas Public Service Co.
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HOUSTON

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Bakke, O. M.
Houston Laboratories
Box 132

Battle, Jack L.
Humble Oil & Refining Co.
Box 2180

Bedford, C. F.
Stanolind Oil & Gas Co.
Box 3092

Bell, S. J.
American Petroleum Co.
Petroleum Bldg.

Blanchard, C. A.
Houston Natural Gas Corp.
Box 1188

Bond, Bethel
The Texas Pipe Line Co.
Box 2332

Bond, Donald H.
The Texas Pipe Line Co.
Box 2332

Cook, Marvin
Humble Oil & Refining Co.
Box 2180

Brance, J. D.
Brance-Krachy Co., Inc.
4411 Navigation Blvd.

Brannon, R. A.
Humble Pipe Line Co
Drawer 2220

Brendel, Robert O.
The Crane Co.
2205 McKinney Ave.

Brewer, T. J.
Humble Oil & Refining Co.
Humble Bldg.

Brown, Charles D.
Aluminum Co. of America
Commerce Bldg.

Buchan, Rudolph C.
Humble Oil & Refining Co.
Box 2180

Caldwell, Joseph A.
Humble & Refining Co.
Box 2180

Calhoun, George H.
Shell Oil Co., Inc.
Box 2099

Campbell, A. B.
National Association of Corrosion Engineers
Southern Standard Bldg.

Carmouche, H. D.
Houston Pipe Line Co.
Box 2412

Carroll, G. O.
Tube-Kote, Inc.
Box 8123

Castle, Harry, Jr.
United Gas Corp.
United Gas Bldg.

Cavenagh, Frank
National Rust Proofing Co.
1717 Blodgett Ave.

Clark, Hezzie
Humble Pipe Line Co.
Drawer 2220

Coates, Charles
Tennessee Gas & Transmission Co.
Box 2511

Davis, Charles T.
Barrett Division, Allied Chemical & Dye Corp.
M & M Bldg.

Day, Stephen D.
Pipe Line Service Corp.
Oil & Gas Bldg.

De Rouen, H. A.
Perrault Brothers
1215 Simsbury Drive

Doremus, E. P.
Cathodic Protection Service
Niels Esperson Bldg.

Dorroh, E. C.
F. H. Maloney Co.
410 Bastrop St.

Fanett, H. M.
United Gas Corp.
Box 2628

Fickel, Lawrence V.
Tennessee Gas & Transmission Corp.
Commerce Bldg.

Fischer, H. E.
Crown Central Petroleum Corp.
Box 1759

Flanagan, J. C.
United Gas Corp.
Box 2628

Fredriechs, Carl C.
Wallace Tiernan Co., Inc.
2415 San Jacinto St.

Gayle, D. R.
Haveg Corp. of Newark, Delaware
4601 Montrose Blvd.

Grebe, H. A.
Cathodic Protection Service
Niels Esperson Bldg.

Gregg, Harris T.
Metal Goods Corp.
Box 1452

Guinn, C. F.
Tidal Pipe Line Co.
Box 1404

Haas, Charles A.
Wyatt Metal & Boiler Works Box 3052

Hamilton, Luke G.
Shell Oil Co., Inc.
Box 2527

Hanes, Henry W.
United Gas Corp.
Box 2628

Harris, Jack W.
Cameron Iron Works, Inc.
Box 1212

Heinen, Lawrence E.
Tube-Kote, Inc.
Box 8123

Henderson, E. L.
United Gas Corp.
Box 2628

Hinkle, George S., Jr.
General Mfg. Co.
1616 Maury St.

Hodson, Fred W.
Johns-Manville Sales Corp.
2212 Polk

Hogwood, Eugene W.
The Texas Pipe Line Co.
317 E. 18th St.

Holm, Emil G.
Tube-Kote, Inc. Box 8123

Holman, O. K.
Texas Gulf Producing Co.
Box 2199

Holsteyn, Derk
Shell Oil Co., Inc.
Box 2527

Hopkins, W. H.
Tuboscope Co.
Commerce Bldg.

Hutchinson, W. J., Jr.
Metal Goods Corp.
16 Drennan St.

Ingels, G. R.
Cook Heat Treating Co. of Texas
6233 Navigation Blvd.

James, Jay R.
The Dow Chemical Co.
Commerce Bldg.

Jessen, Frank W.
Moran Corp.
Mellie Esperson Bldg.

Joplin, J. L.
Buda Engine & Equipment Co. Box 1664

Kelley, V. A.
Bethlehem Steel Co.
Box 2966

Kelly, T. F. P.
James E. Mavor
M & M Bldg.

Kimbro, A. M.
Shell Pipe Line Corp.
Box 318

King, Glenn W.
Brance-Krachy Co., Inc.
4411 Navigation Blvd.

Leonardon, E. G.
Schlumberger Well Surveying Corp.
Box 2175

Loeffler, J. E.
Thornhill-Craver Co.
Box 1184

Lomax, Orville Q.
Humble Pipe Line Co.
Drawer 2220

Luger, Karl E.
K. E. Luger Co.
3618 Washington Ave.

McClughan, Joseph
Converted Rice
5610 Clinton Drive

McCary, S. U.
J. E. Mavor
M & M Bldg.

McLain, Cecil H.
Consulting Engineer
M & M Bldg.

McNeese, C. L.
Houston Lighting & Power Co.
Box 1700

Maher, John F.
John Maher & Co.
Box 381

Mathews, H. W.
Standard Oil Co., of Texas
Petroleum Bldg.

Mavor, James E.
James E. Mavor
M & M Bldg.

Mayes, H. Boyd
Mayes Bros., Inc.
Box 2062

Means, Ben H.
Associated Contractors & Engineers
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Mendive, Anthony J.
Non-Corrosive Products Co. of Texas
Box 7632

Mercer, C. L.
Southwestern Bell Telephone Co.
1121 Capitol

Mitchell, E. B.
Shell Pipe Line Corp.
Box 318

Moran, W. T.
Moran Utilities Co.
Mellie Esperson Bldg.

Morgan, C. L.
United Gas Corp.
Box 2628

Moseley, E. L.
South Chester Tube Co.
Niels Esperson Bldg.

Mudd, O. C.
Shell Pipe Line Corp.
Box 2648

Nee, John W.
Napko Paint & Varnish Works Box 9145

Nellon, C. R.
The National Supply Co.
Box 2616

Nelson, F. M.
Texas Gulf Sulphur Co.
Second National Bank Bldg.

Nelson, Otis A.
Houston Lighting & Power Co.
1016 Walker

Noser, W. P.
Humble Pipe Line Co.
Drawer 2220

Oates, J. J.
Houston Industrial Pipe Line Co.
Commerce Bldg.

Osburn, E. R.
Texas-New Mexico Pipe Line Co.
Box 2332

Parker, Marshall E., Jr.
Pan-American Pipe Line Co.
Mellie Esperson Bldg.

Pecore, Albert E.
Humble Pipe Line Co.
Drawer 2220

Price, Walter J.
Port Commission
Box 5366
Ratcliff, Van W.
Leland Hammer Co.
2211 Preston Ave.
Rector, Paul F.
Humble Oil & Refining Co.
Route 13, Box 515
Rice, R. J.
The International Nickel Co., Inc.
Bankers Mortgage Bldg.
Roberts, John P.
Cameron Iron Works, Inc.
Box 1212
Robinson, T. J.
Bethlehem Supply Co.
7100 Clinton Drive
Rogers, Walter F.
Gulf Oil Corp.
Drawer 2100
Rolfs, E. L.
Crutcher-Rolfs-Cummings
Niels Esperson Bldg.
Ross, George T.
Houston Natural Gas Corp.
Petroleum Bldg.
Scamman, C. W.
Houston Oil Field Material Co. Box 2589
Scherer, Lewis F.
The Texas Pipe Line Co.
Box 2332
Sharpe, L. G.
Humble Pipe Line Co.
Drawer 2220
Shepard, Harry L.
National Carbon Co., Inc.
6915 Van Etten St.
Sheppard, Lyle R.
Shell Pipe Line Corp.
Box 2648
Simpson, A. D., Jr.
United Gas Corp.
Box 2628
Smith, Alonzo L.
Crutcher-Rolfs-Cummings
4012 Willowick Road
Smith, Nowery J.
Nowery J. Smith Co.
8000 Hempstead Road at Eureka
Smith, Thad
Bridgeport Brass Co.
Box 2103
Spafford, P. P.
Stanolind Oil & Gas Co.
Box 3092
Stegner, A. L.
Tennessee Gas & Transmission Co.
Box 2511
Stephenson, James F.
Gulf Refining Co.
Drawer 2100
Sterrett, Elton
Gulf Publishing Co.
3301 Buffalo Drive
Sullivan, R. J.
Humble Oil & Refining Co.
Box 2180
Thayer, Starr
Consulting Engineer
Southern Standard Bldg.
Tisdale, O. R.
Tidal Pipe Line Co.
Box 1404
Turner, Delber W.
Petroleum Rectifying Co.
Box 2546
Tweedie, T. C.
Oil Well Supply Co.
Box 2506
Waldrip, H. E.
Gulf Oil Corp.
Drawer 2100
Walker, Jack G.
Crutcher-Rolfs-Cummings
Esperson Bldg.
Waring, W. H.
Johns-Manville Sales Corp.
2410 Wentworth St.
Wilde, H. D.
Humble Oil & Refining Co.
Humble Bldg.
Williams, P. F.
Pan American Pipe Line Co.
Mellie Esperson Bldg.
Willson, J. P.
Houston Lighting & Power Co.
1016 Walker St.
Wood, C. Lee
Houston Pipe Line Co.
Petroleum Bldg.
Wood, Elgean I.
Westinghouse Electric & Manufacturing Co.
2315 Commerce Ave.
Wood, Hershel J.
Lebanon Steel Foundry
Commerce Bldg.
Yates, J. P., Jr.
Eastern States Petroleum Co., Inc. Box 5008
Young, Sam H.
Insul-Mastis Corp. of America
Box 7382
Zajac, Ted S.
Shell Oil Co., Inc.
Box 2099
Zedler, Otto F.
Gulf Refining Co.
Drawer 2100

IRAAN
Shaeffer, David C.
Pasotex Pipe Line Co.
Box 428

JOINERVILLE
Graves, J. H.
Tidal Pipe Line Co.
Box 777

KATY
Gorden, C. D.
Humble Oil & Refining Co.
Box 276

KILGORE
Zuefeldt, Roy H.
East Texas Salt Water Disposal Co.
Box 633

KINGSVILLE
Dotterweich, Frank H.
Texas College of Arts & Industries

LEVELLAND
Iele, V. J.
Consumers Cooperative Refining Assoc.
Box 978

LUFKIN
Drew, A. E.
Southland Paper Mills, Inc.
Porter, Cover C.
Southland Paper Mills, Inc.

MARSHALL
Reeves, B. M.
Texas Marketers
105 W. Grand St.

MIDLAND
Crawford, Guy G.
Service Engineers Inc.
611 E. Front
Lewis, L. G.
Standard Oil Co. of Texas
Petroleum Bldg.

NEDERLAND
Bedell, William S.
Pure Oil Co. Box 237

ODESSA
Hemphill, D. B.
Phillips Petroleum Co.
Box 6666
Smith, Tracy E.
National Tank Co.
Box 1387

ORANGE
Evans, T. C.
E. I. duPont de Nemours & Co.
Box 2027

PAMPA
Edminster, James W.
Cabot Carbon, Inc.

PORT ARTHUR
Burns, D. L.
Gulf Oil Corp.
Box 701
Shultz, S. T.
The Texas Co.
Box 712
Southern, Charles M.
Atlantic Pipe Line Co.
Box 849
Strawn, Lynn R.
The Texas Co.
Box 712

PORT NECHES
Roden, Harry
The Texas Co.
Box 1537
Traxler, Ralph N.
The Texas Co.
Box 1537

RANGER
Pickrell, David D.
Premier Oil Refining Co. of Texas
Box 75

REFUGIO
Hounsell, W. H.
Hounsell Laboratory
Box 267

SAN ANTONIO
Jenkins, Clark L.
The Goodyear Tire & Rubber Co.
1345 S. Flores St.
McDonald, H. C.
United Gas Pipe Line Co.
Box 421

TAFT
Yates, Louis N.
Sinclair Prairie Oil Co.
Box 576

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Pan-American Refining Corp. Box 401
Dodds, Dan L.
Republic Oil Refining Co.
Box 1404
Forbes, M. C.
Pan-American Refining Corp.
912 18th Ave.
Morris, H. E.
Monsanto Chemical Co.
Pettyjohn, A. R.
Carbide & Carbon Chemicals Corp. Box 471

TYLER
Gordon, Felix B.
Penetron Service Co.
1221 S. Chilton
VAN
Wisdom, James A.
Pure Transportation Co.
Box 25W
WASLACO
Clark, S. C.
Sigler, Clark & Winston
Box 157
WICHITA FALLS
Allen, W. O.
United Gas Pipe Line Co.
Box 780
Bates, A. J.
City of Wichita Falls, Texas
Municipal Auditorium
McGlothlin, E. O.
Refinery Service & Supply
Box 54

UTAH

SALT LAKE CITY
Clough, Harry R.
Mountain Fuel Supply Co.
36 South St.
Clark, R. G.
Utah Oil Refining Co.
Box 898
Littreal, W. Bernard
Utah Oil Refining Co.
Box 898
Purton, T. A.
Utah Power & Light Co.
Box 899

VIRGINIA

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SOUTH CHARLESTON
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WISCONSIN

APPLETON
Brown, Harold H.
Wisconsin Michigan Power Co.
137 W. Mill St.
CUDAHY
Cooper, W. C.
Geo. J. Meyer Mfg. Co.
MILWAUKEE
Beckwith, Laurence J.
Wisconsin Electric Power Co.
3721 McKinley Ave.
Crawford, W. E.
A. O. Smith Corp.
3533 N. 27th St.
Dowling, Roy C.
Wisconsin Telephone Co.
722 N. Broadway
Haase, Harold F.
Marquette University
2919 W. Juneau Ave.
Martin, Arthur R.
Himelblau, Byfield & Co.
611 N. Broadway
Scheil, Merrill A.
A. O. Smith Corp.
3533 N. 27th St.
RACINE
Brinen, Howard F.
Young Radiator Co.
709 S. Marquette St.
SOUTH MILWAUKEE
Earle, Ralph H.
Line Material Co.
WAUKESHA
Thomas, Ralph W.
Waukesha Foundry Co.
Lincoln Ave.
WAUWATOSA
Wicen, Robert E.
Chain Belt Co.
1708 N. 72nd St.

WYOMING

CASPER
Krueger, Louis T.
Northern Utilities Co.
441 S. Center St.
THERMOPOLIS
Satterfield, James L.
Mountain States Power Co.
Box 512

FOREIGN

ARGENTINA

BUENOS AIRES
Hickethier, Carlos F.
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Re, Juan Jose
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State Electricity Commission of Victoria
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CANADA

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Kellam, G. D.
The Canadian Western Natural Gas, Light, Heat & Power Co.
215 Sixth Ave. W.
Mellon, P. D.
The Canadian Western Natural Gas, Light, Heat & Power Co.
215 Sixth Ave. W.
CHATHAM, ONTARIO
Dutton, W. L.
Union Gas Co. of Canada, Ltd. Fifth St.
Russell, G. I.
Union Gas Co. of Canada, Ltd.
Fifth St.
EDMONTON, ALBERTA
McPherson, R. C.
Northwestern Utilities, Ltd.
10124 104th St.
Pitfield, B. W.
Northwestern Utilities, Ltd.
10124 104th St.
Willson, T. R. B.
Northwestern Utilities, Ltd.
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Shawinigan Chemicals, Ltd.
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Shaw, George S.
Shawinigan Chemicals, Ltd.
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Bureau of Mines, Dept. of Mines & Resources
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The International Nickel Co. of Canada, Ltd.
25 King St., W.
Morrison, J. C.
British American Oil Co.
Royal Bank Bldg.
Watson, T. R. B.
Dominion Magnesium, Ltd.
67 Yonge St.
TRAIL, BRITISH COLUMBIA
Busby, A. H. Wilson,
Consolidated Mining & Smelting Co. of Canada, Ltd.

CANAL ZONE

BALBOA HEIGHTS
Miles, John A.
Panama Canal Office
Engineering Division
Administration Bldg.
Collins, James H.
Panama Canal Office
Engineering Division
Administration Bldg.
MARGARITA
McRaven, C. H.
Panama Canal Box 444

DIABOLO HEIGHTS
Mundt, H. W.
Panama Canal
Box 52

COLOMBIA

CUCUTA
Anderson, R. V.
Colombian Petroleum Co.
Apartado 100

DUTCH WEST INDIES

CURACAO
van der Baan, S. J.
Curacaosche Petroleum
Industrie Maatschappij
Emmastad

ENGLAND

LONDON
Footner, H. B.
Shell Petroleum Co., Ltd.
Norman House,
105-109 Strand
Strachan, John F.
Anglo-Iranian Oil Co., Ltd.
Britannic House, Finsbury
Circus

HOLLAND

THE HAGUE
Post, J. H. G.
N. V. De Bataafsche
Petroleum
Maatschappij
Carel van Bylandtlaan 30

MEXICO

MONTERREY,
NUEVO LAREDO
Lobo, H., Jr.
Protexa, S. de R. L.
Zuazua 919 Sur Desp. 304

ROSITA, COAHUILA
Moyle, M. W.
Cia Carbonifera de
Sabinas, S. A.

PALESTINE

HAIFA
Whalley, W. C. R.
Iraq Petroleum Co., Ltd.
Box 309

PERU

LIMA
Vargas, Joaquin
Ingenieria Industrial
South America
Apartado 2830

PUERTO RICO

HATO REY
Badrena, Fernando, Jr.
Ochoa Fertilizer Corp.
Box 117

SOUTH IRAN

ABADAN
Ross, Kenneth B.
Anglo-Iranian Oil Co., Ltd.

SPAIN

BARCELONA
Grau, Vicente Massuet
Instituto Electroquimico
Sanz
Y Massuet S. A.
Enrique Granados 90-92

VENEZUELA

CARACAS
Amador, Frank J.
Creole Petroleum Corp.
Apartado 889
Hackett, A. H.
Venezuelan Telephone Co.
Apartado 1226
Machado, O.
La Electricidad de Caracas
Marron a Pelota 8
Veech, William A.
Westinghouse Electric
International Co.
Apartado 1889

MARACAIBO
Brannan, Albert I.
Mene Grande Oil Co.
Apartado 234
Seib, Karl E.
Mene Grande Oil Co.
Apartado 234
Zauner, John Hudson
Creole Petroleum Corp.
Apartado 172 (La Salina)

TERRITORY OF HAWAII

HONOLULU
Bartz, Ellwood L.
Board of Water Supply,
City & County of Hono-
lulu
Box 3410
Gowans, Louis J.
Honolulu Gas Co., Ltd.
75 S. King St.
Ohrt, Frederich
Board of Water Supply
City & County of Honolulu
Box 3410

Corporate Members

Alabama Gas Company, Birmingham, Alabama.....R. A. Puryear, Jr.
Alabama Power Company, Birmingham, Alabama.....R. L. Harris
Amarillo Oil Company, Amarillo, Texas.....A. F. Cox
American Gas & Electric Corporation, New York, New York.....R. E. Morse
Amercoat Div., American Pipe & Construction Co., Los Angeles, Calif...C. G. Munger
Arkansas Fuel Oil Company, Shreveport, Louisiana.....L. F. Babcock
Arkansas Louisiana Gas Company, Shreveport, Louisiana.....W. A. Broome
Arkansas Power & Light Company, Pine Bluff, Arkansas.....W. A. Green
Atlas Oil & Refining Company, Shreveport, Louisiana.....B. F. Teddlie
N. V. Bataafsche Petroleum Maatschappij, The Hague, Holland.....J. H. G. Post
Bell Telephone Laboratories, Inc., New York, New York.....Robert Pope
Birmingham Gas Company, Birmingham, Alabama.....Charles B. Gamble
Board of Water Supply, City of Honolulu, Hawaii.....Frederich Ohrt
Brance-Krachy Company, Inc., Houston, Texas.....Glenn W. King
The California Company, New Orleans, Louisiana.....E. M. Kipp
Canadian River Gas Company, Amarillo, Texas.....W. M. Clifton
Central New York Power Corporation, Syracuse, New York.....T. C. Moran
Champlin Refining Company, Enid, Oklahoma.....E. G. Wilmoth
Chattanooga Gas Company, Chattanooga, Tennessee.....H. R. Derrick
Chicago Bridge & Iron Company, Chicago, Illinois.....Fred L. Goldsby
Cincinnati Gas & Electric Company, Cincinnati, Ohio.....M. J. Pfeiffer
Cities Service Gas Co., Oklahoma City, Oklahoma.....George H. Baird
Colorado Interstate Gas Company, Colorado Springs, Colo.....C. B. Abbott
Columbia Engineering Corporation, Columbus, Ohio.....C. F. de Mey
Columbian Carbon Company, New York, New York.....Reid L. Carr
Consolidated Gas Electric Light & Power Co. of Baltimore, Md......T. J. Dwyer
Consumers Power Company, Jackson, Michigan.....D. E. Herringshaw
Cosden Petroleum Corporation, Big Springs, Texas.....R. W. Thompson
Dallas Power & Light Co., Dallas Texas.....Robert D. Elliott

Dixie Tank & Bridge Company, Memphis, Tennessee.....W. A. Riley
Ebasco Services, Incorporated, New York, New York.....M. C. Miller
El Paso Natural Gas Company, El Paso, Texas.....C. L. Perkins
Empire Pipe Line Company, Bartlesville, Oklahoma.....Clay Briggs
Florida Power & Light Company, Miami, Florida.....C. H. Summers
Freeport Sulphur Company, New York, New York.....R. C. Hills
Great Lakes Pipe Line Company, Kansas City, Missouri.....C. C. Keane
Gulf Research & Development Company, Pittsburgh, Pennsylvania.....B. B. Wescott
Gulf States Utilities Company, Beaumont, Texas.....W. W. Eckles
Guthrie Gas Utilities Company, Guthrie, Oklahoma.....Merle W. Bahan
Hackensack Water Company, Weehawken, New Jersey.....C. J. Alfke
Houston Natural Gas Corporation, Houston, Texas.....C. A. Blanchard
Houston Pipe Line Company, Houston, Texas.....C. Lee Wood
Interstate Natural Gas Co., Incorporated, Monroe, Louisiana.....O. C. Roddey
Iowa Power & Light Company, Des Moines, Iowa.....C. A. Leland
Kansas-Nebraska Natural Gas Co., Incorporated, Hastings, Nebraska.....L. C. Hill
Keystone Pipe Line Company, Philadelphia, Pennsylvania.....J. M. Williamson
Lion Oil Company, El Dorado, Arkansas.....J. B. Rogerson
Lone Star Gas Company, Dallas, Texas.....J. L. Foster
Louisiana Power & Light Company, New Orleans, Louisiana.....W. T. Hess
Magnolia Pipe Line Company, Dallas, Texas.....D. H. Levy
Memphis Natural Gas Company, Memphis, Tennessee.....Fred D. Stull
Michigan Consolidated Gas Company, Detroit, Michigan.....T. W. Weigele
Mid-Continent Pipe Line Company, Tulsa, Oklahoma.....F. E. Pyeatt, Jr.
Mississippi Gas Company, Meridian, Mississippi.....H. K. Griffin
Mississippi Power & Light Company, Jackson, Mississippi.....G. C. Jones
Mississippi River Fuel Corporation, St. Louis, Missouri.....G. B. Lowther
Mobile Gas Service Corporation, Mobile, Alabama.....Harold T. Strange
Mountain Fuel Supply Company, Salt Lake City, Utah.....Harry R. Brough
National Tank Company, Tulsa, Oklahoma.....Clarence O. Glasgow
Natural Gas Pipeline Co. of America, Chicago, Illinois.....M. V. Burlingame
New York & Richmond Gas Company, Staten Island, New York.....R. Van Vliet
New Orleans Public Service, Inc., New Orleans, Louisiana.....L. G. Ireland
John Nooter Boiler Works Company, St. Louis, Missouri.....Walter Meyer
North Penn Gas Company, Port Allegany, Pennsylvania.....J. H. Isherwood
Northern Natural Gas Company, Omaha, Nebraska.....W. B. Haas
Northwestern Utilities, Limited, Edmonton, Alberta, Canada.....R. C. McPherson
The Ohio Oil Company, Findlay, Ohio.....Ralph M. Slough
Oklahoma Gas & Electric Company, Okahoma City, Oklahoma.....D. O. Lima
Omaha & Council Bluffs Electrolysis Committee, Omaha, Nebraska.....H. W. Bruhn
Pacific Gas & Electric Company, San Francisco, California.....W. R. Schneider
Pan American Pipe Line Company, Houston, Texas.....P. F. Williams
Panhandle-Eastern Pipe Line Company, Kansas City, Missouri.....E. Buddrus
The Peoples Gas Light & Coke Company, Chicago, Illinois.....Leo G. Ranta
The Peoples Natural Gas Company, Pittsburgh, Pennsylvania.....C. A. Erickson, Jr.
Phillips Petroleum Company, Bartlesville, Oklahoma.....I. B. Tietze
Pittsburgh Plate Glass Company, Barberton, Ohio.....Paul J. Gegner
Plantation Pipe Line Company, Atlanta, Georgia.....W. G. Horstman
Premier Oil Refining Co. of Texas (Pipe Line Div.) Ranger, Texas.....D. D. Pickrell
Public Service Corp. of New Jersey, Newark, New Jersey.....George H. Blake
Pure Transportation Company, Chicago, Illinois.....D. C. Glass
Republic Natural Gas Company, Dallas, Texas.....Byron B. Boatright
Richfield Oil Corporation, Los Angeles, California.....D. F. Purdy
Rochester Gas & Electric Corporation, Rochester, New York.....E. R. Crofts
San Diego Gas & Electric Company, San Diego, California.....L. M. Klauber
Scranton-Spring Brook Water Service Co., Wilkes Barre, Pennsylvania. Rulison Evans
The Shamrock Oil & Gas Corporation, Amarillo, Texas.....Dan P. Long
Shell Pipe Line Corporation, Houston, Texas.....H. H. Anderson
Sinclair Refining Co. (Products Pipe Line), Columbus, Ohio.....W. W. Baker
Sioux City Gas & Electric Company, Sioux City, Iowa.....W. J. Dougherty
Skelly Oil Company, Tulsa, Oklahoma.....Rex L. Smith
Socony-Vacuum Oil Company, Inc., New York, New York.....S. Kleinheksel
Socony-Vacuum Oil Co., White Eagle Division, Wichita, Kansas....Harry K. Phipps

Sohio Pipe Line Company, Cleveland, Ohio.....C. E. Spahr
Southeastern Pipe Line Company, Atlanta, Georgia.....B. W. Winters
Southern Counties Gas Co. of California, Los Angeles, California..N. K. Senatoroff
Southern Natural Gas Company, Birmingham, Alabama.....J. W. Yeldell
Southern Union Gas Company, Dallas, Texas.....J. C. Reid
Southland Paper Mills, Incorporated, Lufkin, Texas.....A. E. Drew
Southwestern Gas & Electric Company, Shreveport, Louisiana.....F. N. Wilkes
Spang-Chalfant Div. of The National Supply Co., Tulsa, Oklahoma.....H. G. Texter
Standard Oil Co. of California, San Francisco, California.....J. M. Evans
Standard Oil Co. of Indiana (Pipe Line Dept.), Chicago, Illinois.....H. E. Fisher
Standard Oil Development Co., Esso Engineering Dept., Elizabeth, N. J.....F. C. Fyke
Stanolind Pipe Line Company, Tulsa, Oklahoma.....J. B. Harshman
Stratton Pipe Line Corporation, Corpus Christi, Texas.....R. W. Graves
Tennessee Gas & Transmission Company, Houston, Texas.....Charles Coates
Texas Electric Service Company, Fort Worth, Texas.....P. M. Cordell
The Texas-Empire Pipe Line Company, Tulsa, Oklahoma.....F. A. Stivers
Texas Gulf Producing Company, Houston, Texas.....O. K. Holman
Texas-New Mexico Pipe Line Company, Houston, Texas.....E. R. Osburn
The Texas Pipe Line Company, Houston, Texas.....L. F. Scherer
Texas Public Service Company, Galveston, Texas.....P. E. Nicholls
Transit & Storage Co. (Ohio-Michigan Pipe Line Div.) Port Huron, Mich....L. Garcia
Union Oil Co. of America, Los Angeles, California.....Vance N. Jenkins
Union Producing Company, Shreveport, Louisiana.....H. R. Bennett
United Gas Corporation, Houston, Texas.....J. C. Flanagan
United Gas Pipe Line Company, Shreveport, Louisiana.....M. A. Abernathy
Utah Oil Refining Company, Salt Lake City, Utah.....R. G. Clark
Washington Gas Light Company, Washington, D. C.....Everett J. Boothby

Associate Members

Alloy Steel Products Company, Linden, New Jersey.....Emil G. Holmberg
Aluminum Co. of America, New Kensington, Pennsylvania.....Ellis D. Verink, Jr.
American Steel & Wire Company, Cleveland, Ohio.....H. H. Febrey
Associated Contractors & Engineers, Houston, Texas.....Ben H. Means
Barrett Division, Allied Chemical & Dye Corp., New York, N. Y...George B. McComb
Bart Manufacturing Company, Belleville, New Jersey.....S. G. Bart
Bethlehem Steel Company, Bethlehem, Pennsylvania.....S. C. Frye
Briggs Bituminous Composition Co., Philadelphia, Pennsylvania.....J. K. Wadick
Cameron Iron Works, Incorporated, Houston, Texas.....Jack W. Harris
Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.....R. B. Mears
Crutcher-Rolfs-Cummins, Incorporated, Houston, Texas.....E. L. Rolfs
Dearborn Chemical Company, Chicago, Illinois.....E. M. Converse
Dow Chemical Company, The, Midland, Michigan.....Arthur Smith, Jr.
Federal Telephone & Radio Corporation, Newark, New Jersey.....N. W. Wunderlich
Good-All Electric Manufacturing Company, Ogallala, Nebraska.....R. A. Goodall
Hill, Hubbell & Co., Div. General Paint Corp., Cleveland, Ohio.....M. M. Bowen
International Nickel Company, The, New York, New York.....W. Z. Friend
Jacobs Wind Electric Company, Inc., Minneapolis, Minnesota.....M. L. Jacobs
Johns-Manville Sales Corporation, New York, New York.....L. A. Baldwin
James E. Mavor, Houston, Texas.....James E. Mavor
Midwestern Engine & Equipment Company, Tulsa, Oklahoma.....G. O. Glandon
Natasco Company, Tulsa, Oklahoma.....C. W. Montgomery
National Cooperative Refinery Association, McPherson, Kansas.....E. J. Mary
National Lead Company, Research Labs., Brooklyn, New York.....Alex. Stewart
Nordstrom Valve Div., Rockwell Mfg. Company, Pittsburgh, Pa.....E. E. Matheson
Owens-Corning Fiberglas Corporation, Toledo, Ohio.....Frank L. Myers
Perrault Brothers, Tulsa, Oklahoma.....Lewis Perrault
Pipe Line Service Corporation, Franklin Park, Illinois.....A. D. Innes
H. C. Price Company, Bartlesville, Oklahoma.....J. S. Dewar
A. O. Smith Corporation, Milwaukee, Wisconsin.....W. E. Crawford
D. E. Stearns, Shreveport, Louisiana.....D. E. Stearns
Union Carbide & Carbon Corporation, New York, New York.....George A. Sands
Koppers Co., Inc., Wailes Dove-Hermiston Dept. Westfield, N. J.....R. C. Stromquist

A Message from Your Officers

This Month's Contributor

IVY M. PARKER, Chairman, Publication Committee

WE WANT you, as an active member of the National Association of Corrosion Engineers, to know more of the functions of the Publication Committee. As defined in the By-Laws, this committee has control of all the publications of the Association. It has the responsibility of setting forth rules governing preparation, presentation, acceptance, and publication of all papers. In addition, sub-committees may be appointed, when necessary, to carry out this work and to further technical and research activities of the Association.

You are well acquainted with CORROSION as the only regular official publication of the Association. Perhaps you are not as familiar with the other activities of the committee. A sub-committee on rules has published a pamphlet on preparation and presentation of papers. The Abstract Sub-Committee is setting up a system for filing and indexing of abstracts. A compilation of abstracts of articles on corrosion for 1945 is being printed, and plans have been made for making this an annual publication.

Material for the magazine is divided into sections on technical papers, news items, and abstracts. For the first time an extensive effort is being made to organize the literature on the subject of corrosion. Often unnecessary time and energy are spent in checking, abstracting, and reading articles which are merely rewrites of data presented elsewhere. Therefore, issues of CORROSION contain, in addition to new technical papers, reprints of outstanding articles from other technical magazines. Through the assistance of the American Coordinating Committee on Corrosion in securing regular contributions of abstracts from various organizations, our Abstract Section now gives a survey of approximately 95 percent of all articles published in the field of corrosion. Thus our publication contains a concise but comprehensive coverage of corrosion literature, which should prove invaluable to all whose work is related to this field.

NACE News

LOCAL SECTION ACTIVITIES

A round table discussion of the subject, Corrosion Problems in Piping and Pumps, highlighted the November 24 meeting of the Cleveland (Ohio) Section of the North Central Region of NACE. Panel leaders in the discussion were C. F. Dunasky, Harshaw Chemical Co.; F. E. Vandeveer, East Ohio Gas Co.; F. J. Leonhard, Cleveland Electric Ill., Co.; Paul Gegner, Pittsburgh Plate Glass Co.; and M. C. Miller, Ebasco Services, Inc. Various phases of corrosion in pipelines, pumps and chemical plant piping were discussed by those on the panel, with questions and remarks directed by the audience. Everett Gosnell, Colonial Iron Works, presided at the meeting. Carl E. Heil, of the Heil Process Equipment Corp., secretary-treasurer of the Section, reported a good attendance.

MEMBERS of the National Association of Corrosion Engineers, who reside in the San Francisco, California, Bay Area have petitioned for recognition as a Local Section of the Western Region of NACE.

S. T. Shultz, paint chemist of The Texas Company, Port Arthur, held the interest of 40 NACE members with a very constructive paper on the subject of Protective Coatings at the November 19 meeting of the Corpus Christi (Texas) Section of the South Central Region. During the business meeting that followed presentation of the paper by Mr. Shultz; S. L. Richards, Jr., was elected chairman of the Section, to succeed R. W. Graves, who was transferred to the Shreveport, Louisiana, offices of his company, the Stratton Pipe Line Corp. A nominating committee was also appointed to prepare a list of nominees for office in 1948. The slate of candidates will be presented during the January meeting, followed by a mail ballot, results of which will be announced at the February meeting, and at which time the new officers will assume their respective duties.

Mr. Richardson, of the Rosson-Richards Co., was formerly vice-chairman of the Section. T. S. Moffatt, Jr., Southern Alkali Corporation, is presently secretary-treasurer.

NACE-ECS CATHODIC PROTECTION SYMPOSIUM ATTRACTS RECORD CROWD

Success crowned the efforts of members of the National Association of Corrosion Engineers and the Electrochemical Society who cooperated in arranging the Cathodic Protection Symposium, held December 8 through 10 at the William Penn Hotel, Pittsburgh, Pa. The excellent meeting, which was jointly sponsored by the two organizations, drew a record attendance of 266, of whom 197 were either members of NACE or ECS, 67 guests and two students.

A committee was appointed by each society to cooperatively arrange the program, and the large attendance reflects the success they achieved. The NACE group was headed by F. L. LaQue, who was assisted by O. C. Mudd, M. C. Miller and D. B. Good, while the ECS group was headed by R. B. Mears, and assisted by I. A. Denison and H. A. Pray.

Twenty-four Papers Presented

Twenty-four papers, covering various phases of corrosion control by the cathodic protection means, were presented. Morning, afternoon and evening sessions were held the first day, Monday, December 8, with morning and afternoon sessions being held Tuesday, April 9, and Wednesday, April 10.

Chairmen of the various sessions were R. M. Burns, J. C. Warner, O. C. Mudd, George W. Heise, F. J. McElhatton, Robert Pope, J. M. Pearson, and R. A. Brannon.

The program opened with G. E. English, Aluminum Company of America, reading the paper, Electrochemical Principles of Cathodic Protection, which Mr. English had prepared in collaboration with R. H. Brown, also of Aluminum Co. of America. Then followed presentation by M. C. Miller, Ebasco Services, Inc., of the paper, Characteristics and Field Use of Electrical Instruments for Corrosion Investigations, Electrolysis and Cathodic Protection; and the paper, Characteristics of Half Cells Used as Reference Electrodes, by P. Fugassi, Carnegie Institute of Technology.

Authorities on Subject

Other papers presented by authorities on the subject were:

Laboratory Methods of Determining Current Density Required for Cathodic Protection, by R. B. Mears, Carnegie-Illinois Steel Corp.

Null Method of Determining Current Density Required for Cathodic Protection, by R. F. Hadley, Susquehanna Pipe Line Co.

Field Methods for Determining the Current Requirements for Cathodic Protection (Other than the Null Method), by N. P. Peifer, Manufacturers Light & Heat Co.

Detection, Measurement and Mitigation of Stray Currents, by Frank Fry, Public Service Company of Colorado.

Detection and Measurement of Currents Other than Stray Currents, including Magnetic Earth Currents, by Lyle B. Sheppard, Shell Pipe Line Corp.

Coordination of Cathodic Protec-

tion Installations to Avoid Interference with Adjacent Structures, by L. B. Nelson, Shell Pipe Line Corp.

The Use of Rectifiers as an External Source of Protection Currents, by F. A. Waelterman, Benwood-Linze Co.

The Use of Wind Driven Generators as an External Source of Protective Currents, by M. L. Jacobs, Jacobs Wind Electric Co.

Economic Factors Bearing on Application of Cathodic Protection, by D. B. Good, Texas Pipe Line Co.

Locations and Materials for Anodes for Impressed Current, by Derk Holsteyn, Shell Oil Co.

Advantages and Disadvantages of Various Current Sources, by C. W. Evans and G. R. Olson, United Gas Pipe Line Co.

Physical and Chemical Characteristics of Zinz Anodes, by E. A. Anderson, New Jersey Zinc Co.

Current Output of Light Metal, Galvanic Anodes as a function of Soil Resistivity, by E. D. Verink, K. K. Reid and E. R. Diggins, Aluminum Company of America.

Fundamental Characteristics of Magnesium Galvanic Anodes, by H. A. Robinson, The Dow Chemical Co.

Practical Use of Galvanic Anodes, by H. Wahlquist, Ebasco Services, Inc., and H. M. Fanett, United Gas Corp.

Behavior of Experimental Zinc-Steel Couples Underground, by I. A. Denison and Romanoff, National Bureau of Standards.

Characteristics of Zinc and Aluminum Galvanic Anodes in Sea Water, by T. P. May, The International Nickel Co., Inc.

Corrosion and Protection of Underground Power Cables, by L. J. Gorman, Consolidated Edison Co.

Application of Cathodic Protection to Water Tanks, Process Vessels and Miscellaneous Equipment, by F. J. LeFebvre, Electro Rust-Proofiing Corp.

Relations Between Protective Coatings and Cathodic Protection, by Guy Corfield, Southern California Gas Co.

Cathodic Protection in the Control of Stress-Corrosion Cracking, by H. J. McDonald and R. D. Misch, Illinois Institute of Technology.

The Canadian Government has sponsored the formation of a Subcommittee on Standardization of

Forty Papers Scheduled During 1948 Conference

• The technical program for the 1948 Conference and Exhibition the National Association of Corrosion Engineers will hold in St. Louis, April 5 through 8, is rapidly nearing completion, with Mars G. Fontana, of The Ohio State University and Chairman of the Technical Program Committee, now preparing a report on the program.

Broken down into ten specific symposia, the technical program cross-sections industrial corrosion problems. Forty papers, prepared by authorities in their respective fields, covering the practical as well as theoretical aspects of the causes of corrosion and means of its control and mitigation are scheduled.

Two concurrent sessions will be held the morning of the second day, Tuesday, April 6, starting at 9:00. On the third and final days of the meeting, two concurrent sessions will be held both in the morning and in the afternoon. Afternoon sessions begin at 2:00.

All meetings will be held in the Hotel Jefferson, as will the Exhibition and all functions of the Association.

GENERAL INTEREST

Corrosion Test Methods. The function of this sub-committee is to assemble, exchange, and develop information which would be useful in the formulation of improved methods of laboratory, plant, and field corrosion testing. The group will concentrate on test methods applicable under conditions which exist in Canada. The membership, consisting of representatives of industry, government agencies and universities is divided into the following working panels:

Panel on Laboratory Testing, chairman — H. P. Godard, head, Chemical Division, Aluminum Laboratories, Ltd., Kingston.

Panel on Plant Corrosion Testing, chairman—H. J. Butterell, metallurgical engineer, International Nickel Co., of Canada, Ltd., Toronto.

Panel on Outdoor Exposure Testing, chairman—E. T. Hurley, chief chemist, Department of Research and Development, Canadian National Railways, Montreal.

Officers of the newly formed committee are: R. R. Rogers, head, Chemical Metallurgy Section, Bureau of Mines, Department of Mines and Resources, Ottawa, chairman; with Mr. Godard, vice chairman.

The Instrument Society of America will hold their third Instrument Conference and Exhibit at Convention Hall, Philadelphia, Pa., September 13-17, 1948. The exhibit will be known as the American Instrument Fair, and will occupy 200 booths on the arena floor. A highlight of the exhibit will be an instruments historical display. Technical sessions will be held Monday to Friday from 10 A.M. to 12:30 P.M., and Monday, Tuesday and Thursday from 8 to 10:30 P.M. These sessions will be jointly sponsored by American Institute of Physics; Industrial Instruments and Measurements Division, American Society of Mechanical Engineers; Instruments and Measurements Committee, American Institute of Electrical Engineers; and Joint Sub-committee of Electronic Instruments, American Institute of Electrical Engineers, with ISA.

At a recent meeting of the Houston Paint, Varnish and Lacquer Association the following were elected officers: president, Harry M. Kuhn, president Kuhn Paint and Varnish Co.; vice president, D. W. Skillern, Thompson Hayward Chemical Co.; secretary-treasurer, Charles M. Nuhler, South Texas Cotton Oil Co. Mr. Kuhn was formerly vice president of the Association. The outgoing officers were President E. B. McCullough, president of the McCullough Co., and Secretary-Treasurer Carl F. Murray, advertising manager, Napko Paint and Varnish Works.

Robert C. Stanley, president of The International Nickel Co., Inc., New York, announced a reduction of 1¼ cents per pound in the Company's price for refined nickel in the United States, effective January 1,

1948, simultaneously with a like reduction in the United States import duty on refined nickel provided for in the recently signed reciprocal trade agreement between the United States and Canada. Prices outside of the United States are not affected by the duty and remain unchanged. New price for 99.9 percent electrolytic nickel from the Port Colborne, Ontario, refinery will be 33¾ cents a pound instead of 35 cents.

The semi-annual Amercoat Sales and Technical meeting was held recently in Chicago, Ill., during which new products were introduced to the sales force, and various corrosion and contamination problems discussed. Specific examples were used emphasizing the causes of damage to steel and concrete and the contamination of sensitive chemicals and edible products; and the Company's products which could be used. Recommendations made were based on field tests of sufficient length to provide a fairly accurate guide to the quality of each coating. Industrial problems discussed included those of the petroleum, chemical, rayon, pulp and paper, meat packing, bottling, canning, dairy, starch, wine, marine, water works and sewage industries.

Capacitron Company, Inc., Chicago, Ill., has been purchased by the Jefferson Electric Company, Bellwood, Illinois. Chief products of Capacitron included oil-filled and electrolytic condensers, a-c motor starting capacitors and Ballastrons, a type of condenser which provides high power factor correction for low power factor fluorescent lamp ballasts. Present plans call for the continued production of the Capacitron company products, with enlargement and improvement as required.

The first aluminum sheet ever rolled with modern equipment in Mexico is now coming off the newly completed sheet mill of Aluminio Industrial Mexicano, near Mexico City. The sheet is fabricated from Canadian ingot produced at Arvida, Quebec. Aluminum, Ltd., of Canada, has an interest in the Mexican controlled company, of which Charles G. Seifert, Sr., Mexico City, is president. In addition to the new sheet mill, and a foil mill now nearing completion, plans call for an aluminum paste plant to be ready for operation some time in 1948. The present annual capacity of the sheet, foil and paste plants is set at approximately three million pounds.

Saran Lined Pipe Company, a newly organized firm, will act as exclusive distributors for The Dow Chemical Company's recently developed specialty pipe and fittings. The pipe and fittings, lined with the new plastic, were developed for use where highly corrosive materials are handled in manufacturing process.

Solvay Process Company and Solvay Sales Corporation have been merged into their parent company, Allied Chemical and Dye Corporation. The business of the companies will be continued under the names, Solvay Process Division, Allied Chemical and Dye Corp., and Solvay Sales Division, Allied Chemical and Dye Corp. No change in personnel was made.

PERSONALS

Irving **A. Denison** has been appointed Chief of the National Bureau of Standard's Underground Corrosion Section, according to E. U. Condon, director of the Bureau. Mr. Denison will direct fundamental studies of underground corrosion, a program begun in 1922, and involving the burying and periodic excavation of many thousands of specimens of pipe materials and protective coatings in representative soils of this country. From 1922 to 1929, he was engaged in analysis and classification of soils for the Bureau of Chemistry and Soils, U. S. Department of Agriculture. He has been with the soil corrosion section of the National Bureau of Standards since 1929. Mr. Condon also announced that **Thomas G. Digges** has been appointed chief of the Thermal Metallurgy Section of the Bureau, succeeding D. J. McAdam, retired. Mr. Digges has been a member of the Metallurgy Division since January, 1920.

Glenn W. King resigned from the Brance-Krachy Co., Houston, Texas, effective January 1, and joined the Cochran Equipment Co., of the same city. Previously sales representative in the Gulf Coast area for the distributor of the Westinghouse Electric Company's rectifier, Mr. King will remain associated with the oil industry, handling construction equipment for oil field usage.

W. A. James, formerly of Battelle Memorial Institute, Columbus, Ohio, and **R. E. Johnson,** formerly with Gustin-Bacon Mfg. Co., Kansas City, Kansas, and **Miss G. F. Payne,** previously associated with C. J. Patterson Co., Kansas City, Mo., have joined the technical staff of the Midwest Research Institute, Kansas City, Mo. All are members of the Institute's Inorganic Chemistry Section.

Van W. Ratcliff, Houston, Texas, has joined the Rufnek Chemical Company staff as chief engineer. Mr. Ratcliff is in charge of development and control for the company, which is engaged in water treatment and allied oil field products.

Reeve Hoover, Washington, D.C., has been named chairman of the board of Commercialores, Inc., New York. The company was established recently by a private group for purpose of developing a large kyanite deposit in South Carolina—a silicate of alumina used in super-duty refractories and in other branches of the ceramic industry.

Charles E. Weeks has been appointed assistant to the operating vice president, Southern Alkali Corp., subsidiary of Pittsburgh Plate Glass Co., Pittsburgh, Pa. Mr. Weeks has been with the company since it was established in 1934 at Corpus Christi, Texas.

1948, simultaneously with a like reduction in the United States import duty on refined nickel provided for in the recently signed reciprocal trade agreement between the United States and Canada. Prices outside of the United States are not affected by the duty and remain unchanged. New price for 99.9 percent electrolytic nickel from the Port Colborne, Ontario, refinery will be 33¾ cents a pound instead of 35 cents.

The semi-annual Amercoat Sales and Technical meeting was held recently in Chicago, Ill., during which new products were introduced to the sales force, and various corrosion and contamination problems discussed. Specific examples were used emphasizing the causes of damage to steel and concrete and the contamination of sensitive chemicals and edible products; and the Company's products which could be used. Recommendations made were based on field tests of sufficient length to provide a fairly accurate guide to the quality of each coating. Industrial problems discussed included those of the petroleum, chemical, rayon, pulp and paper, meat packing, bottling, canning, dairy, starch, wine, marine, water works and sewage industries.

Capacitron Company, Inc., Chicago, Ill., has been purchased by the Jefferson Electric Company, Bellwood, Illinois. Chief products of Capacitron included oil-filled and electrolytic condensers, a-c motor starting capacitors and Ballastrons, a type of condenser which provides high power factor correction for low power factor fluorescent lamp ballasts. Present plans call for the continued production of the Capacitron company products, with enlargement and improvement as required.

The first aluminum sheet ever rolled with modern equipment in Mexico is now coming off the newly completed sheet mill of Aluminio Industrial Mexicano, near Mexico City. The sheet is fabricated from Canadian ingot produced at Arvida, Quebec. Aluminum, Ltd., of Canada, has an interest in the Mexican controlled company, of which Charles G. Seifert, Sr., Mexico City, is president. In addition to the new sheet mill, and a foil mill now nearing completion, plans call for an aluminum paste plant to be ready for operation some time in 1948. The present annual capacity of the sheet, foil and paste plants is set at approximately three million pounds.

Saran Lined Pipe Company, a newly organized firm, will act as exclusive distributors for The Dow Chemical Company's recently developed specialty pipe and fittings. The pipe and fittings, lined with the new plastic, were developed for use where highly corrosive materials are handled in manufacturing process.

Solvay Process Company and Solvay Sales Corporation have been merged into their parent company, Allied Chemical and Dye Corporation. The business of the companies will be continued under the names, Solvay Process Division, Allied Chemical and Dye Corp., and Solvay Sales Division, Allied Chemical and Dye Corp. No change in personnel was made.

PERSONALS

Irving A. Denison has been appointed Chief of the National Bureau of Standard's Underground Corrosion Section, according to E. U. Condon, director of the Bureau. Mr. Denison will direct fundamental studies of underground corrosion, a program begun in 1922, and involving the burying and periodic excavation of many thousands of specimens of pipe materials and protective coatings in representative soils of this country. From 1922 to 1929, he was engaged in analysis and classification of soils for the Bureau of Chemistry and Soils, U. S. Department of Agriculture. He has been with the soil corrosion section of the National Bureau of Standards since 1929. Mr. Condon also announced that **Thomas G. Digges** has been appointed chief of the Thermal Metallurgy Section of the Bureau, succeeding D. J. McAdam, retired. Mr. Digges has been a member of the Metallurgy Division since January, 1920.

Glenn W. King resigned from the Brance-Krachy Co., Houston, Texas, effective January 1, and joined the Cochran Equipment Co., of the same city. Previously sales representative in the Gulf Coast area for the distributor of the Westinghouse Electric Company's rectifier, Mr. King will remain associated with the oil industry, handling construction equipment for oil field usage.

W. A. James, formerly of Battelle Memorial Institute, Columbus, Ohio, and **R. E. Johnson,** formerly with Gustin-Bacon Mfg. Co., Kansas City, Kansas, and **Miss G. F. Payne,** previously associated with C. J. Patterson Co., Kansas City, Mo., have joined the technical staff of the Midwest Research Institute, Kansas City, Mo. All are members of the Institute's Inorganic Chemistry Section.

Van W. Ratcliff, Houston, Texas, has joined the Rufnek Chemical Company staff as chief engineer. Mr. Ratcliff is in charge of development and control for the company, which is engaged in water treatment and allied oil field products.

Reeve Hoover, Washington, D.C., has been named chairman of the board of Commercialores, Inc., New York. The company was established recently by a private group for purpose of developing a large kyanite deposit in South Carolina—a silicate of alumina used in super-duty refractories and in other branches of the ceramic industry.

Charles E. Weeks has been appointed assistant to the operating vice president, Southern Alkali Corp., subsidiary of Pittsburgh Plate Glass Co., Pittsburgh, Pa. Mr. Weeks has been with the company since it was established in 1934 at Corpus Christi, Texas.

NEW PRODUCTS, EQUIPMENT AND MATERIALS

A quick-reading all-metal humidity indicator, designed for use in industry and laboratory, has been announced by the Weston Electrical Instruments Corp., Newark, N. J. The indicator provides relative humidity readings said to be accurate within ±1 percent for general conditions. The instrument is of wet and dry bulb type, and features the all-metal Weston Laboratory Thermometers, self-supporting wet-bulb wick covering the thermal element, sturdy construction. A simplified slide rule calculator gives direct readings, thus eliminating the need for tables or psychrometric charts. The calculator on the face of the instrument indicates relative humidity from 10 to 100 percent.

United States Gasket Co., 651 N. 10th St., Camden, N. J., announce a chemically inert gasket, known as Chemiseal. The gasket is a product of special techniques which impart resilient characteristics to thermoplastic materials. The gaskets are fabricated from Teflon (polyletrafluoretheylene) which is resistant to chemical action of organic and inorganic acids, bases, esters, ketones, aromatic hydrocarbons, halogenated solvents and acids. To date, molten sodium, and fluorine under pressure, are the only materials tested which cause any change. Temperatures from —200°F to +500 can be accommodated without brittleness or decomposition. The anti-adhesive properties of the gasket are unique in that they never stick to flanges or become coated with materials, greatly enhancing their value in product purity control, as well as preventing equipment damage during replacement.

Two new series of precision electrical indicators are being produced by the Taco West Corp., 2620 South Park Ave., Chicago, Ill., under the trade name Ver-Tell. A model I millivoltmeter pyrometric indicator which is thermally compensated includes thermostatic automatic cold junction compensation with the more sensitive Hypar compensator, which derives its operative energy from a line supply.

Micro Metallic Corp., 193 Bradford St., Brooklyn 7, N. Y., announced that as a result of a newly developed butt welding technique, it is now possible to join together six-inch by eighteen-inch unit sheets of porous stainless steel, to form large sheets of any required size. A modified form of "Heliarc" (inert gas shielded tungsten arc welding) is used. The new welding technique is particularly applicable in making up large sheets when the filter material is 0.100 or more thick. Many types of special shapes can be welded from one-sixteenth-inch thick material. The welds are said to be strong and ductible. In addition to producing filter sheets of any area, the company can weld the porous material to solid stainless steel members, such as enclosing rings, flanges, etc. The

weld assembled sheets can be sheared, drilled and machined, within limitations that can be subjected to rolling and drawing operations; and they can be welded again after machining and forming.

The Crane Company, Chicago, Ill., reinstated Ni-Resist gate valves. The company discontinued manufacture of this valve prior to the last war. The valves are of the wedge disc, outside screw and yoke type, and are being regularly furnished with screwed end in sizes from one to two inches, and with flanged ends in sizes from one to eight inches. All valves in sizes three inches and smaller have clamp type bolted bonnet, and sizes four to eight inches inclusive have the conventional type of bolted bonnet. Body and bonnet of all valves, the disc in sizes four inches and larger, and the gland in sizes three inches and smaller are made of Ni-Resist. The strength and physical characteristics of this material are about the same as cast iron; but resistance to corrosion, erosion, and wear is definitely better. To add to their corrosion resistance, the stem and body seats, the disc rings in sizes three inches and smaller, and the disc in sizes four inches and larger are made of Crane 18-8 alloy steel. Additional information can be secured by writing the company at 836 S. Michigan Avenue, Chicago.

Owens-Corning Fiberglas Corp., Toledo, Ohio, is now turning out a lightweight, high temperature insulating material, which is being offered in felt and bulk form. The new material is said to be capable of withstanding temperatures to 1800°F..

USEFUL BOOKS, LITERATURE AND PAMPHLETS

American Hot Dip Galvanizers Association, Inc., has available prints of a 16 mm motion picture sound film on zinc coating by the hot-dip galvanizing process. Its showing time is 25 minutes. The picture shows the steel base metal actually rusting as viewed through a microscope, the cleaning of the metal by the pickling process, and the coating with zinc. Each process is explained, as are the metallurgical photographs of the construction of a zinc coating and its formation. Uses and applications of galvanizing as a form of rust-proofing are shown. Prints can be secured by writing to Stuart J. Swensson, secretary-treasurer, American Hot Dip Galvanizers Association, Inc., 1611 First National Bank Building, Pittsburgh 22, Pa.

Literature is available from the Wilkinson Products Company, P. O. Box 1774, Wilshire-La Brea Station, Los Angeles 36, California, covering the pipe locater manufactured by the company. Specifications and uses of this induction type locater are given. Illustrations of applications in locating submerged structures are also included.

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Corrosion Abstracts

Mechanism of Oxidation and Tarnishing. U. R. EVANS. Paper before 91st Gen. Mtg. Louisville, Ky. (1947) Apr. 9-12. Electrochem. Soc. Preprint 91-5 (1947).

The thickening of oxide (or sulfide) films takes place in different ways. Outward migration of cations and electrons, normally by lattice defects, gives parabolic film growth, but mechanical breakdowns due to compressional stresses may lead to other equations. Rectilinear, logarithmic, and parabolic equations are presented to represent the different rate processes involved, and the types of deterioration (flaking, shear-cracking, etc.) associated with each form are set forth. It is shown that blistering should lead to rectilinear or logarithmic thickening according as the rifts in the blister walls do or do not admit oxygen. Flaking should lead to periodical recommencement of rapid oxidation. Shear cracking may produce parabolic, rectilinear or intermediate forms. The theory is applied to interpret the results of Vernon and others, and particularly to explain why conditions prevailing at the time when a specimen is first exposed decide the corrosion-rate, which often continues unchanged even if subsequently conditions fluctuate. 55 references.

Flat Slabs on Cast-Iron Columns Increase Usable Space. Eng. News-Record, **138,** 6, 88-89 (1947) Feb. 6.

In a hog-cooler building of a meat-packing plant, the designers solved a corrosion problem and added useful interior space by employing unprotected cast iron for interior columns supporting all-flat slab floors. Capitals and drop panels were eliminated under the ceiling by incorporating in the slabs steel-cannel grillages attached to the cast iron columns. These grillages supply needed shear resistance around the columns.—INCO.

New X-Ray Method of Studying Oxide Layers. J. BERNARD. Bull. Soc. Chem. France, **11,** 327-331 (1944); J. Inst. of Metals and Metall. Abs., **14,** 51-52 (1947) Feb.

The rotating-film method, employing a diffraction standard, permits precise measurement of the parameters in the small surface elements, using radiation that penetrates only slightly. The K_a line of cobalt was used, with powdered silver as the diffraction standard, in experiments with ferrous oxide. Observation seems to offer new proof of the diffusion of metal through the oxide layer during the oxidation.—INCO.

The Role of Algae in Corrosion. HENRY C. MYERS. J. AWWA **39,** 322-324 (1947) Apr.

Describes corrosion due to algae which occurred in open steel tanks belonging to the California Water & Telephone Co., in Southern California. The theory of this type of corrosion and attempts to control it are discussed. Covering the tanks to cut out the sunlight proved to be the least expensive and most effective control method.—BLR.

Results Obtained from Five Years of Cathodic Protection on 24-Inch Gas Line Rapidly Deteriorating from Bacterial Corrosion. WM. E. HUDDLESTON. Corrosion, **3,** 1-7 (1947) Jan.

The line was coated with a commercial tar enamel, but was not wrapped. Results of inspection are described. Cathodic protection provided excellent results.—BLR.

Use of Corrosion Inhibitors in Products Pipelines—A Survey of Practices. IVY M. PARKER. Corrosion, **3,** 157-168 (1947) Arp.

Results of a questionnaire survey of 20 companies operating products pipelines are discussed in the body of the report. Details are given in appendices. 11 ref.—BLR.

Relationship Between Corrosiveness of Soils and Their Resistivity. Pritula (Neft. Khoz. **24,** 6/7, 52-8 (1946).

From a discussion of literature (27 ref.) it is concluded that a close correlation exists between resistivity values and the degree of corrosive attack of soils on pipelines, etc. The following scale for evaluation of soils is proposed: extremely high corrosiveness, with resistivities of less than 5 ohm/m; high—5 to 10; fair—10 to 20; normal—20 to 100; and low—at resistivities above 100 ohm/m.

Technical Developments of 1946 (in Metal Finishing). R. A. MOZER, Met. Fin., **45,** 1, 50-55+ (1947) Jan.

Covers corrosion prevention, polishing, cleaning, pickling, coatings (electrodeposited, hot-dipped, anodised, etc.), electroforming, metallizing non-conductors, metal colouring, testing. 213 ref., many U. S. patents. —BNF.

The Phosphatization of Steel. E. HERZOG. Technique Moderne, **38,** 21 and 22, 256-261 (1946) Nov.

Account is given of production of phosphate films and of their properties, with curves showing dependence on different factors. Short section on treatment of zinc alloys is included.—BNF.

Influence of Various Additions in the Phosphating of Metals. II. Influence of Additions of Nitrates of the Univalent Metals. I. I. HAIN. J. App. Chem. (USSR), **19,** 5 and 6, 527-534 (1946) (In Russian).

Influences on acidity of the phosphating solution, duration of gas formation, structure, color, and corrosion resistance of the coating were investigated.—BLR.

The Effect of Peening Upon Residual Welding Stresses. E. P. DEGARMO, F. JONASSEN AND J. L. MERIAM, Univ. of Calif. Paper before AWS, 27th Ann. Mtg., Atlantic City, Nov., 1946. Welding J., **25,** 10, 616-S-623-s (1946) Oct.

In butt welds hot peening does not reduce residual stresses unless the last passes are peened. Longitudinal residual stresses of welds may be reduced to less than 20,000

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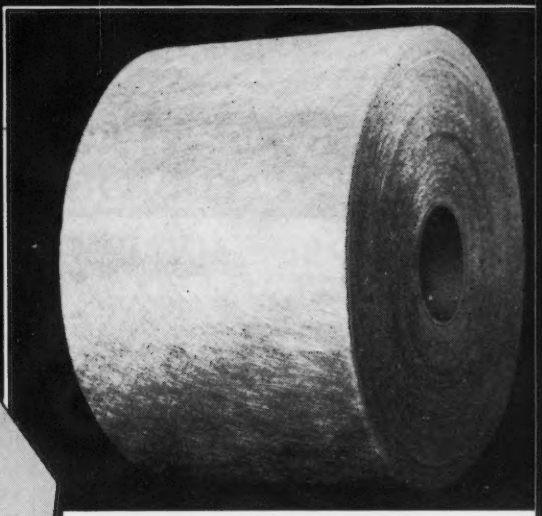

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psi by peening the weld after it is completed and cooled nearly to ambient temperature. Peening to obtain max. reduction of longitudinal residual stresses, to reduce the transverse compression at ends of welds or the transverse compression at ends of welds or the transverse tension, must be applied to weld and adjacent plate metal for at least 2 in. on either side of weld after cooled to ambient temperature. Deposition of last passes of a weld after all stresses from previous passes have been eliminated will produce residual stresses of approx. the same magnitude as would have existed had no stress relief taken place on previous passes. Paper is from series covering work at University of California under OSRD contract, entitled "Residual Stresses in Ship Welding." Full directions and graphs accompany article.—INCO.

The Relative Corrosion Resistance of Magnesium Alloys in Salt Water. L. W. Eastwood, F. W. Fink and J. A. Davis. Light Metal Age, **4**, 4, 16-18+ (1946) Apr.

Existing data show that ½% zinc in magnesium alloys with 6-9.5% aluminum and 0.2% manganese reduces the corrosion rate produced by a cyclic immersion in 3% salt solution. An increase from 0.5-3% zinc reduces the corrosion rate to some extent. The 0.5% zinc content represents a good compromise whereby the major benefits of the zinc on salt-water corrosion are obtained without sacrificing the amenability of the low zinc alloys to heat treatment or accentuating their susceptibility to microporosity. New data show that allows of high purity, namely those having 0.001% iron or

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less have markedly improved resistance to salt-water corrosion regardless of zinc content. 7 refs.
—INCO.

Corrosion—The Great Destroyer. D. J. FERGUS. Corrosion, **3,** 55-66 (1947) Feb.

Use of magnesium and magnesium alloy rods for anodic protection of hot water tanks is recommended. Results of this system as compared with ordinary galvanizing are shown by photographs. The magnesium has a high electrode potential and builds a protective film on the tank wall.

Mechanism of Corrosion of Iron by Water as a Function of pH—Role of Dissolved Oxygen-Degasification by Heat, Vacuum, or Chemical Means. CH. CABANES. Chaleur et ind. **27,** 261-270 (1946); Chem. Abs., **41,** 5, 1194 (1947) Mar. 10.

The mechanism of corrosion of iron by water is reviewed, and the role of dissolved oxygen is discussed, as well as several commercial forms of degasifiers.—INCO.

Thickness Detector. Chem. Eng. **54,** 1, 143 (1947) Jan.

A new accoustic thickness gauge, Audigage, Model FMSS-4, announced by Branson Instruments, Inc., Danbury, Connecticut, can determine from one side only the thickness of a variety of materials, including aluminium. This lightweight, portable, self-contained instrument contains its own power supply and utilizes a crystal-type gauge head, powered by a frequency-modulated electronic oscillator.
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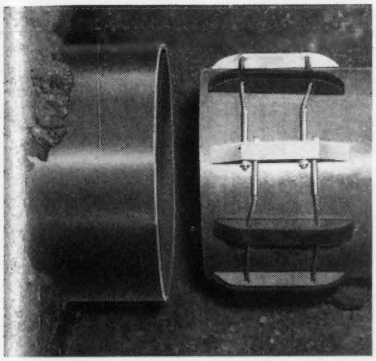

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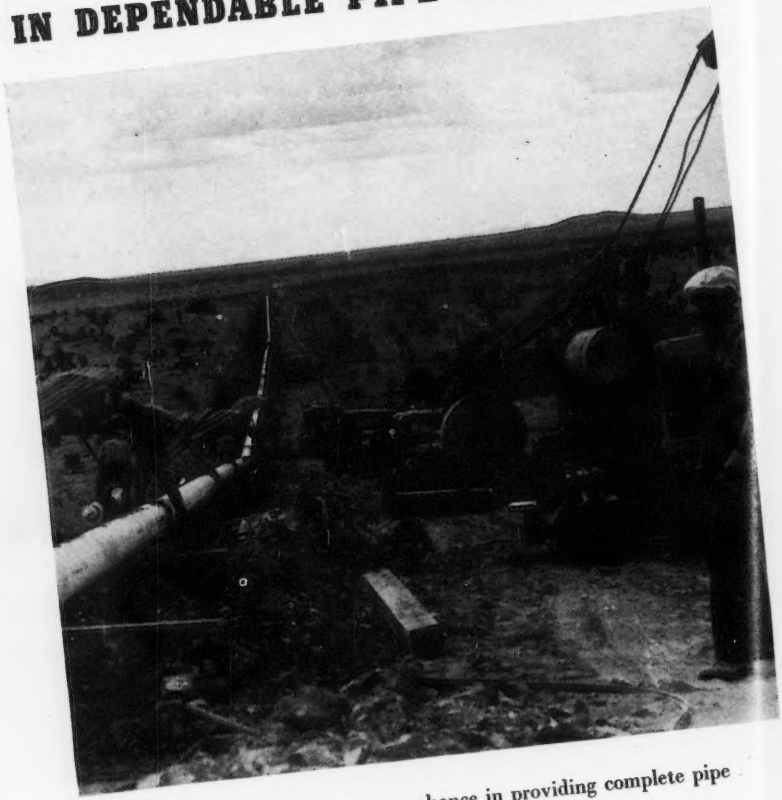

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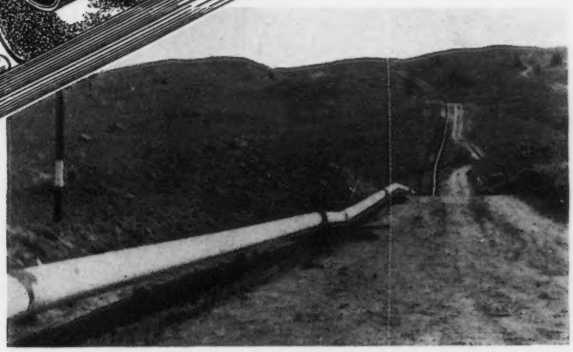

BITURINE, or other high grade coatings are products of modern chemical engineering skill; their protective qualities against electrolytic or all corrosive actions are the result of chemical research.

HILL, HUBBELL pipe protection, mechanically applied indoors, assures the positive effectiveness of good coatings. HILL, HUBBELL thorough pipe cleaning, temperature controlled priming and hot coating—and—wrapping, give you the maximum in modern pipe protection.

For TIME enduring pipe protection specify the H & H process.

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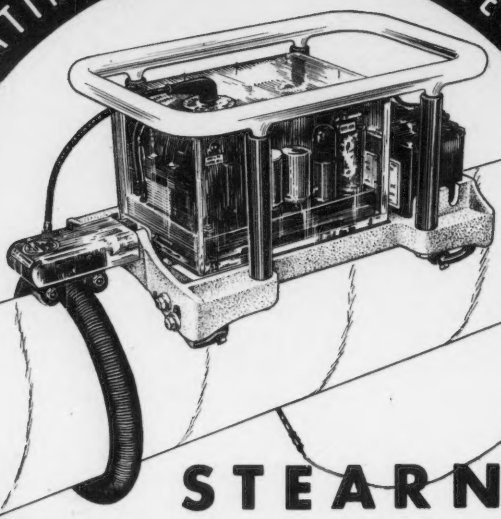
BETTER COATINGS CONSERVE STEEL



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